Y/SUB/90-00206C/5

Y-12

OAK RIDGE
Y-12
PLANT

MARTIN MARIETTA

COMPREHENSIVE GROUNDWATER MONITORING PLAN FOR THE DEPARTMENT OF ENERGY Y-12 PLANT OAK RIDGE, TENNESSEE

Prepared by

GERAGHTY & MILLER, INC.
Under Purchase Order 12Y-00206C

September 1990

for

Environmental Management Department
Health, Safety, Environment, and
Accountability Division

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Contract No. DE-AC05-84OR21400

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

#461

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ACRONYMS

ACL	Alternate Concentration Limit
BCK	Bear Creek Kilometer
BCV	Bear Creek Valley
BCVWDA	Bear Creek Valley Waste Disposal Area
CABF	Cochran's Approximation of the Behrens-Fisher (Student t-test)
CERCLA	Comprehensive Environmental Response and Liability Act
CM	Corrective Measures
DOE	U.S. Department of Energy
EAP	Environmental Assessment Plan
EAR	Environmental Assessment Report
EPA	U.S. Environmental Protection Agency
GWPS	Ground-Water Protection Standard
GWQAR	Ground-Water Quality Assessment Report
GWQAP	Ground-Water Quality Assessment Plan
HWDU	Hazardous Waste Disposal Unit
MCL	Maximum Contaminant Level
NPDES	National Pollution Discharge Elimination System
ORNL	Oak Ridge National Laboratory
PCPA	Post-Closure Permit Application
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
SWDF	Solid-Waste Disposal Facility (non-hazardous waste)

ACRONYMS
(continued)

SWMU	Solid Waste Management Unit
TDHE	Tennessee Department of Health and Environment
TSD	Treatment, Storage, and Disposal (Unit)
TVA	Tennessee Valley Authority
UEFPC	Upper East Fork Poplar Creek
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WMA	Waste Management Area

1.0 INTRODUCTION

Geraghty & Miller, Inc. (Geraghty & Miller) was retained by Martin Marietta Energy Systems (Energy Systems), operator of the Y-12 Plant under contract to the U.S. Department of Energy (DOE), to develop a comprehensive plan for monitoring surface water and ground-water quality at the Plant. Development of this plan was accorded in a Memorandum of Understanding (MOU) signed in 1983 by the DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Health and Environment (TDHE). Specifically, item XI of the MOU required DOE to prepare a comprehensive monitoring plan for surface water and ground water of the Y-12 Plant, including all sampling locations and monitored parameters. In addition, included in DOE order 5400.1 issued in November 1988, is a requirement for each DOE facility to have a separate plan.

The development of a comprehensive plan for surface-water and ground-water monitoring at the Y-12 Plant has closely mirrored advances in the monitoring efforts at the Plant. In direct response to the MOU, an initial plan was prepared in 1983 by Union Carbide Nuclear Division (Pritz, 1983). Expansion of the surface and ground-water monitoring programs at the Y-12 Plant since 1984, however, quickly rendered the initial monitoring plan obsolete. In an effort to update the plan to more accurately represent the current level of monitoring efforts, the first draft of a new plan was prepared by Geraghty & Miller and submitted to Energy Systems in May 1988. The plan has been revised to incorporate all the waste sites at the Y-12 Plant, in particular solid-waste management units (SWMUs) and underground storage tanks (USTs) which were identified by Energy Systems subsequent to the first draft.

The ultimate objective of this monitoring plan is clear; to provide the quality and variety of data needed to characterize contaminant plumes to the extent necessary to make a scientific evaluation of their potential adverse impacts upon human health and the environment and to support engineering design of remedial actions to mitigate those impacts. This fundamental concept is paramount at the Y-12 Plant where the intermingling of contaminant releases from multiple unrelated waste sites, which are regulated under overlapping regulatory programs, has threatened to bind progress in a morass of regulatory requirements. The concepts presented herein have as a basis the single most important factor controlling the rate of transport of contaminants, the hydrogeologic system.

The sub-objectives of this plan are to (1) address all potential sources of contamination, (2) comply with all applicable State and Federal regulations, and (3) enhance the effectiveness of monitoring resources and efforts through phased sequential implementation that is initially directed towards the primary transport pathways and systematically focused on individual source areas.

Section 2.0 identifies the major components addressed in the plan. In subsequent sections each component is more fully discussed beginning with an overview of the hydrogeologic system (Section 3.0) upon which the plan is based. Section 4.0 lists all the sites which have currently been identified at the Y-12 Plant, identifies the regulatory program under which each site is administered, and outlines the specific regulatory requirements for surface water and ground-water monitoring. The technical approach proposed to unify the monitoring requirements and achieve the objectives is presented in Section 5.0. Procedures in use for quality assurance are discussed in Section 6.0, and references are provided in Section 7.0. An expanded bibliography to assist readers seeking more detailed information concludes the report (Section 8.0).

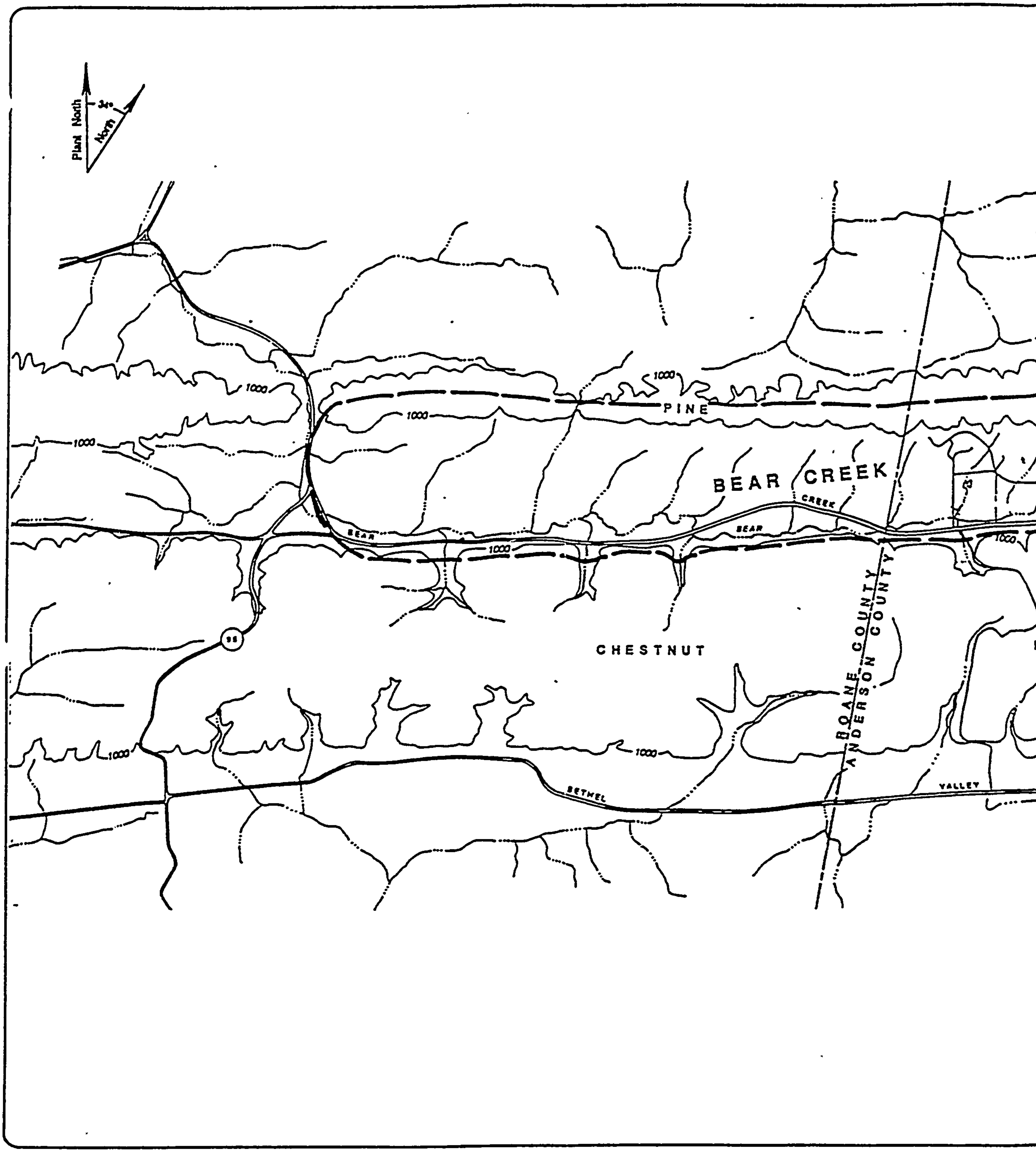
2.0 PROGRAM COMPONENTS

The Y-12 Plant poses unique and challenging problems to the development and implementation of a comprehensive plan to monitor surface water and ground-water quality. To address these problems, a monitoring program consisting of five basic components is proposed. These components are: (1) the consolidation of the Y-12 Plant waste sites into their respective hydrogeologic regimes, (2) the demonstration of compliance with all applicable state, federal, and DOE regulations, (3) formulation of a strategy for delineating contaminant plume extent and migration, (4) the utilization of standardized quality-control protocols throughout all aspects of the comprehensive monitoring program, and (5) the unification of technical reports into more cohesive forums for data presentation and interpretation. A brief discussion of each of these components is provided in the following sections.

2.1 HYDROGEOLOGIC REGIMES

For the purposes of this plan, the hydrogeologic system at the Y-12 Plant has been subdivided, based upon topography, surface-water drainage, and ground-water flow patterns, into three distinct hydrogeologic regimes (Figure 2-1). This approach has two basic advantages. First, it provides a basis to unify monitoring efforts at the Y-12 Plant waste sites into more manageable groups for planning and reporting purposes. Second, it allows for monitoring efforts to be tailored to the hydrogeologic characteristics of each regime. Section 3.0 provides a basic description of the hydrogeology of the Y-12 Plant area and the basis for subdividing the hydrogeologic system.

The topography of the Y-12 Plant area provides the basis for the first and most obvious subdivision of the hydrogeologic system. The Y-12 Plant and a majority of the waste sites associated with the Plant lie in Bear Creek Valley (BCV). Other waste-disposal sites are located on Chestnut Ridge. Although hydraulically interconnected to some degree,



Plant North
34°
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CHESTNUT
ROANE COUNTY
ANDERSON COUNTY
BETHEL
VALLEY

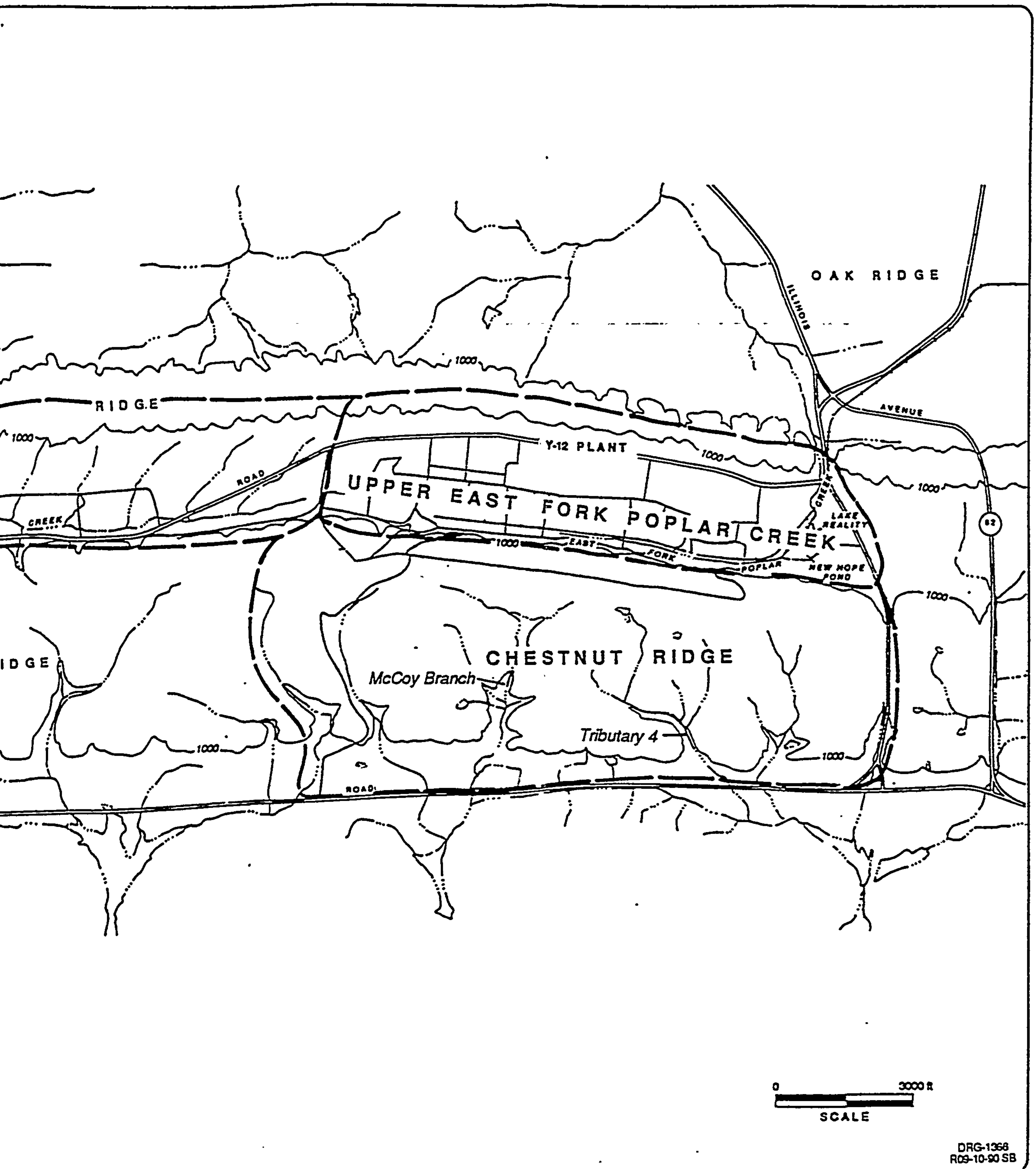


Figure 2-1. Hydrogeologic Regimes for Surface and Ground-Water Monitoring Programs at the Y-12 Plant

BCV and Chestnut Ridge both have distinctly different hydrogeologic characteristics. Thus, Chestnut Ridge has been separated from BCV as a distinct hydrogeologic regime.

Surface-water drainage characteristics and ground-water flow patterns provide the basis for subdividing the hydrogeologic system in BCV. Two watersheds are present in BCV; the Upper East Fork Poplar Creek (UEFPC) watershed and the Bear Creek watershed. The topographic divide between these two watersheds is located near the west end of the Y-12 Plant. A corresponding ground-water flow divide has also been documented (Geraghty & Miller 1987e). Based upon these surface water and ground-water flow divides, BCV has been divided into the Bear Creek hydrogeologic regime and the UEFPC hydrogeologic regime.

2.2 REGULATORY COMPLIANCE

Current State and Federal regulations, and internal DOE orders and guidelines, define the minimum performance standards for all surface water and ground-water monitoring activities at the Y-12 Plant. Because the waste sites at the Y-12 Plant are regulated under several different regulatory programs, demonstrating how regulatory compliance will be achieved and maintained will ultimately determine the acceptance of this plan by state and federal regulatory agencies. Section 4.0, therefore, lists all the waste sites currently identified at the Y-12 Plant, identifies the regulatory programs under which each site is administered, and outlines the surface water and ground-water monitoring requirements specified by these programs. The section is concluded with a discussion on how the proposed monitoring approach will maintain compliance with applicable regulations, orders, and guidelines.

2.3 CONTAMINANT PLUME ASSESSMENT STRATEGIES

As noted in Section 2.1, dividing the hydrogeologic system at the Y-12 Plant into separate hydrogeologic regimes provides for the development of contamination assessment strategies that are tailored to the hydrogeologic conditions, source-area characteristics, and ground-water quality conditions in each regime. Thus, separate but interrelated contamination assessment strategies are proposed for the Bear Creek, UEFPC, and Chestnut Ridge hydrogeologic regimes.

The contaminant plume assessment strategies for all three hydrogeologic regimes share a fundamental objective: protection of human health and the environment. Although institutional controls on public access to the Y-12 Plant work to significantly reduce the exposure to contaminated media, contaminated surface water and ground water may exit the controlled access areas at the Y-12 Plant and enter areas of unrestricted access where a greater potential for exposure may exist. Therefore, the contaminant assessment strategy for each hydrogeologic regime includes surface water and ground-water quality monitoring at these exit pathways and points of exposure. This will work to ensure that the quality of water leaving the Y-12 Plant area is adequately monitored such that, in the unlikely event that contamination is detected at levels which may pose a threat to human health, interim corrective measures can be implemented.

Until recently, contamination assessment efforts at the Y-12 Plant have primarily been focused on the waste-management sites located in the Bear Creek hydrogeologic regime. The approach to contamination assessment at these sites has essentially involved starting at or near each site and systematically extending the investigation to identify the horizontal and vertical extent of the contaminant plumes. However, expansion of the site-specific monitor-well networks has shown that contaminants from each site are migrating towards the same exit pathway (the Maynardville Limestone) where a considerable degree of intermingling has occurred. Furthermore, the monitoring efforts at these sites are fast approaching a "saturation point" whereupon time-synchronous sampling cannot be achieved, costs are prohibitive, and timely data-analysis and interpretation cannot be performed. Thus, a contamination assessment strategy for the Bear Creek hydrogeologic regime involving the integration of the site-specific programs into one overall assessment effort is outlined in Section 5.1.

Current monitoring data indicate that the intermingling of contaminant plumes in the UEFPC hydrogeologic regime may be more pervasive than in the Bear Creek hydrogeologic regime. This is a result of the large number and proximity of the waste sites located in the UEFPC hydrogeologic regime. Because the contaminant plumes in the UEFPC hydrogeologic regime may have a number of separate sources, site-specific monitoring to determine the relative contribution of each source to the contaminant plumes (if possible) would be a complex, prolonged, and costly process. Thus, the proposed strategy for contaminant plume assessment in the UEFPC hydrogeologic regime is not focused on individual sites, but is directed at determining the overall extent of contamination irrespective of source area contributions. Details of this proposed approach are provided in Section 5.2.

Waste sites located on Chestnut Ridge are widely spaced, and there are no current indications that contaminant plumes from separate source areas have overlapped. Thus, no significant changes to the on-going site-specific monitoring programs are recommended. However, should future monitoring data indicate that contaminants from a site on Chestnut Ridge have migrated into Bear Creek Valley, monitoring for those contaminants will be incorporated into the assessment strategies outlined for the Bear Creek or UEFPC hydrogeologic regime. A discussion of the contamination assessment strategy for Chestnut Ridge is provided in Section 5.3.

2.4 QUALITY CONTROL PROTOCOLS

The ultimate purpose of all monitoring activities at the Y-12 plant is to provide the data needed to detect and assess a contamination release, and to evaluate, select, and design engineering alternatives to mitigate such releases. It is therefore of the utmost importance that the monitoring data be of the highest possible accuracy and reliability. Through standardization of the methods and procedures employed during investigations of ground-water contamination and surface-water quality at the Y-12 Plant, Energy Systems has made significant strides towards these goals. Standardized monitor-well designs and installation methods, well construction standards and abandonment procedures, ground-water sampling protocols, and laboratory analytical methods have been established, documented, and are currently employed in the ground-water monitoring programs at the Y-12 Plant. In addition, a standardized method for the evaluation and analysis of water-quality data has been developed to aide data interpretations. A discussion of each of these quality assurance practices is provided in Section 6.0.

2.5 REPORTING

On-going monitoring programs at the Y-12 Plant currently generate large amounts of surface water and ground-water quality data. As per regulatory requirements, much of these data are presented and interpreted in narrowly focused site-specific reports. Consequently, the information needed to gain a clear understanding of the current status of monitoring activities and hydrogeologic studies is disseminated throughout numerous site-specific reports and documents. This has led to situations in which state and federal regulators have been left with the impression that crucial monitoring and hydrogeologic data have not been collected, when in fact the data are available but are presented in reports that the regulators have not reviewed or were unaware existed. Furthermore, as it has become more evident that ground-water contamination in some areas of the Y-12 Plant may have several different sources, site-specific reports have proven cumbersome and inadequate forums for presenting and evaluating plume contributions and relationships between source areas.

To address these problems, a single annual report is proposed as the forum for presenting the results of surface water and ground-water monitoring activities in each hydrogeologic regime (Bear Creek, UEFPC and Chestnut Ridge). This approach, which has already been proposed to the TDHE and implemented in preparation of the 1989 GWQARs in no way affects the evaluation and presentation of the extent of site-specific ground-water contamination; site-specific conditions are thoroughly discussed in separate sections of the report for the hydrogeologic regime in which the site is located. Furthermore, this approach provides for a more cohesive presentation and discussion of intermingling contaminant plumes in each hydrogeologic regime, and the site-specific contributions and relationships to this contamination. Details regarding the contents of the report for each hydrogeologic regime are discussed in Section 5.0.

3.0 HYDROGEOLOGIC OVERVIEW

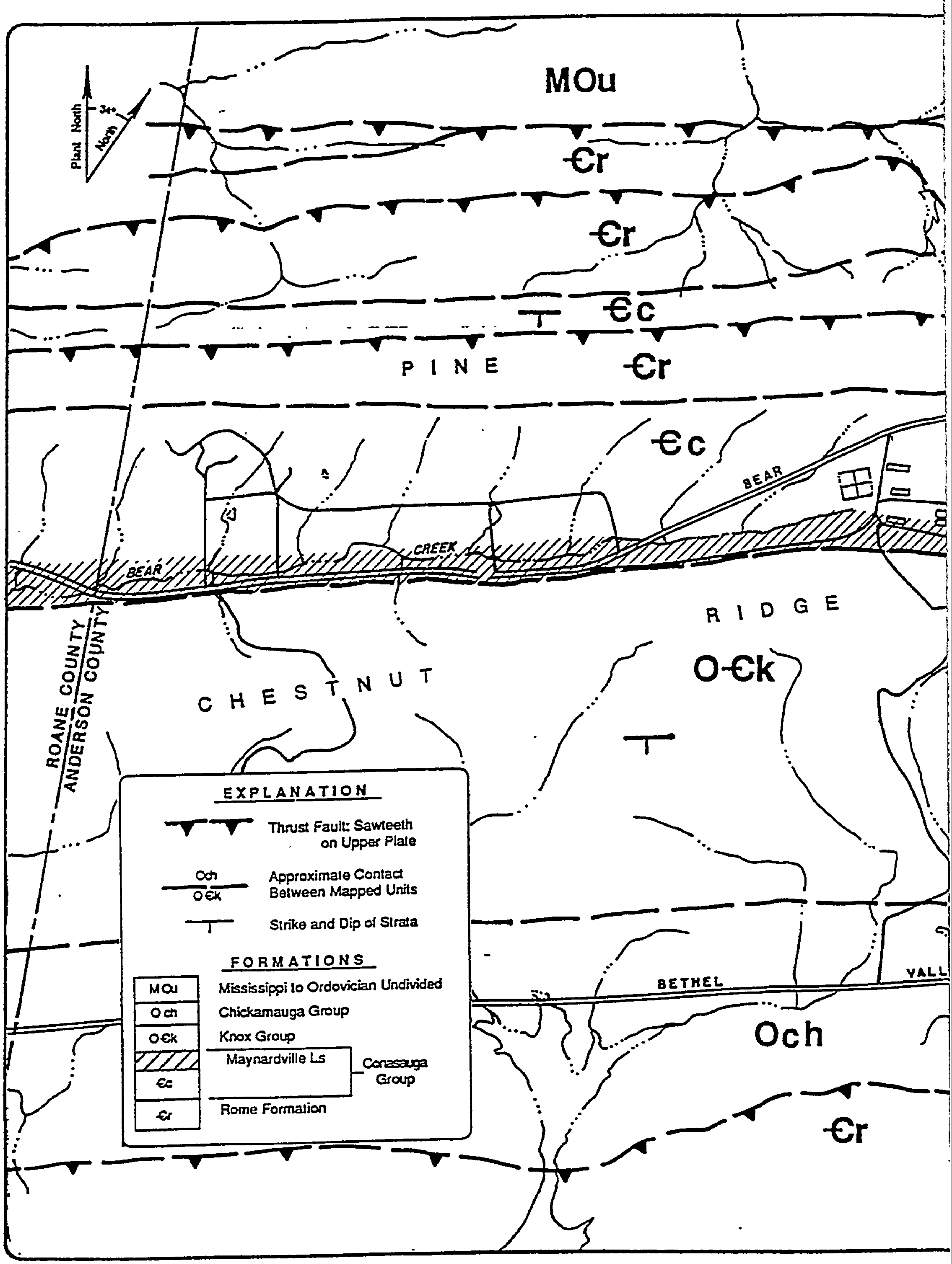
A general discussion of hydrogeologic conditions in the vicinity of the Y-12 Plant is provided in the following sections. The purpose of this discussion is to furnish the reader with a basic understanding of the hydrogeologic system at the Y-12 Plant; it is not intended as a definitive description of hydrogeologic conditions. Numerous papers, articles, and reports have been prepared which contain more detailed discussions of various aspects of the Y-12 Plant hydrogeology. A list of many of these reports are provided in the bibliography (Section 8.0).

3.1 GEOLOGY

The Y-12 Plant is located within the southern part of the Valley and Ridge physiographic province, which is characterized by narrow elongated ridges and valleys that trend in a northeast-southwest direction. The ridges are typically formed on resistant sandstones, siltstones, and siliceous limestones whereas the valleys are commonly underlain by less resistant shales and soluble carbonates. Structurally, the Valley and Ridge province is characterized by thrust faults and subsidiary faults that are part of a major decollement of the Southern Appalachian thin-skinned orogenic thrust belt. Movement along thrust faults in the region towards the northwest has placed older stratigraphic sequences on top of younger ones.

3.1.1 Stratigraphic Units

Most of the waste management units at the Y-12 Plant are located in Bear Creek Valley (BCV), which is flanked to the northwest by Pine Ridge and to the southeast by Chestnut Ridge. Pine Ridge is formed by Cambrian shales and siltstones of the Rome Formation (Figure 3-1), which represent the oldest geologic strata in the vicinity of the Plant. Conformably overlying the Rome Formation are Cambrian limestones, shales, and


Plant North
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CHESTNUT
ROANE COUNTY
ANDERSON COUNTY
BETHEL
VALL
Och
Ꞓr
EXPLANATION
Thrust Fault: Sawteeth on Upper Plate
Och
OꞒk
Approximate Contact Between Mapped Units
Strike and Dip of Strata
FORMATIONS
MOu Mississippi to Ordovician Undivided
O ch Chickamauga Group
OꞒk Knox Group
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Conasauga Group
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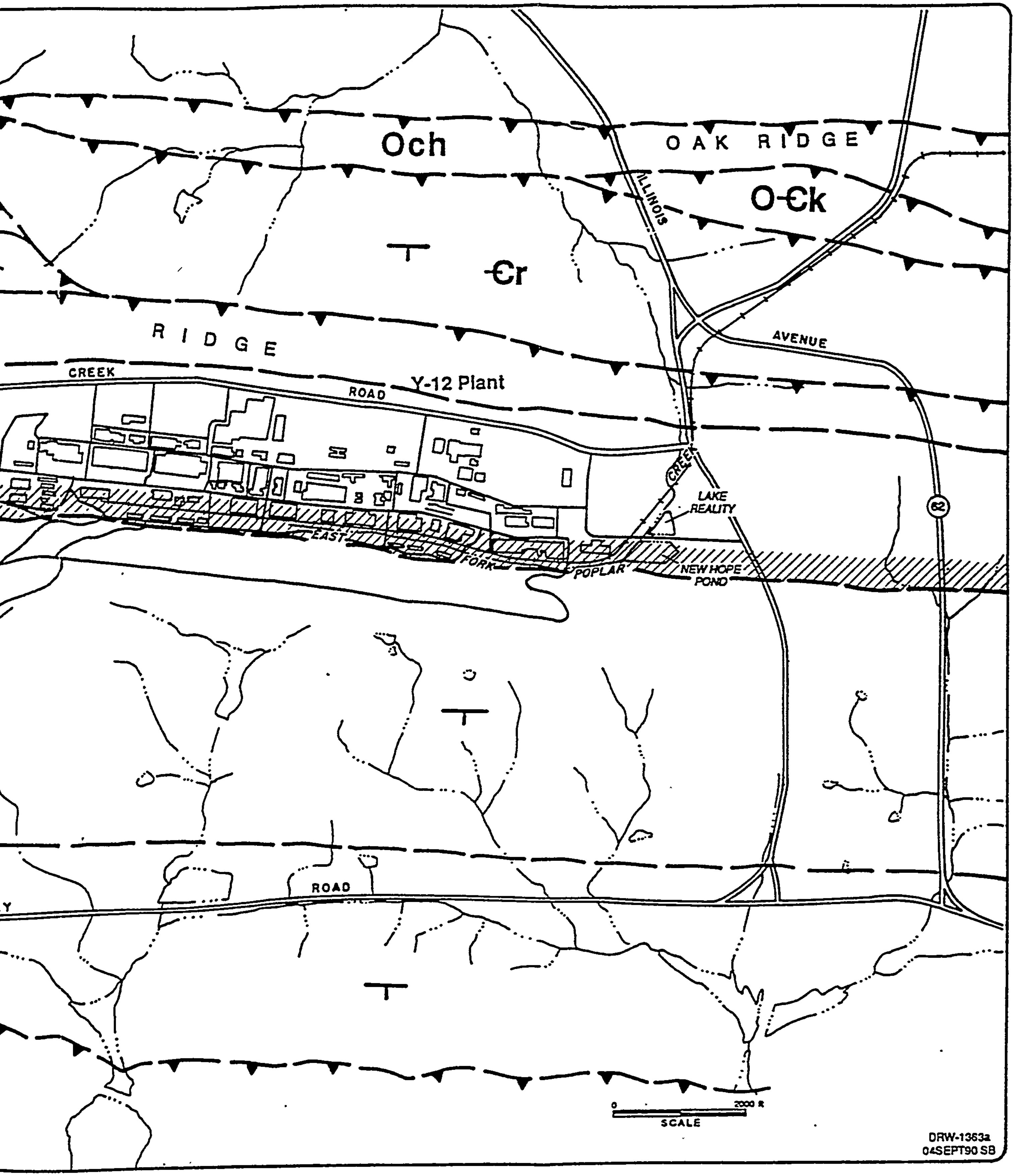

Figure 3-1. Bedrock Geology at the Y-12 Plant

siltstones of the Conasauga Group which underlie BCV. The strata of the Conasauga Group have been divided, based on lithology, into six formations. These formations are, from oldest to youngest, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale, and Maynardville Limestone. Cambro-Ordovician dolostones of the Knox Group, which unconformably overly the Conasauga Group, form Chestnut Ridge. A geologic column illustrating the stratigraphic relationships between geologic units at the Y-12 Plant is provided on Figure 3-2.

Bedrock units throughout the Y-12 area generally are overlain by unconsolidated deposits of varying thickness consisting of weathered bedrock that is referred to locally as residuum, man-made fill, alluvium, and colluvium. Residuum comprises a majority of the unconsolidated materials in this area, and is especially well developed on Chestnut Ridge.

3.1.2 Structural Relationships

Strike and dip of bedding in the Y-12 area are generally N55°E and 45°SE, respectively. However, at any given location, the strike may range from N35° to 65°E and the dip may vary from 30°SE to nearly vertical (Rothschild, et. al., 1984.). The dominant structural features at the Y-12 Plant are the Copper Creek and White Oak Mountain thrust faults. The Copper Creek Fault dips 25° to 30°SE at the ground surface, and is exposed southwest of BCV (Figure 3-1). The White Oak Mountain Fault in the Oak Ridge area is a zone of faulting in which a number of individual thrust faults have juxtaposed various stratigraphic units. This fault zone is exposed northwest of Pine Ridge. A geologic cross-section illustrating the regional structural framework is provided on Figure 3-3.

Joint and fracture sets are a common structural feature in the vicinity of the Y-12 Plant. These features were produced by compressional forces of the Alleghany Orogeny which thrust the formations of the eastern Appalachian Basin westward. Several studies of the joint sets in the area of Bear Creek Valley indicate that orientations and spacing are

Age	Group	Lithology	Formation	Approximate Thickness (ft) King and Haase 1987	Milici 1973	McMaster 1963
Middle Ordovician	Chickamauga		Undivided	Not Determined	Not Determined	1,750 (undivided)
Lower Ordovician	Knox		Mascot Formation	Not Determined	400-800	3,000 (undivided)
			Kingsport Formation		200-320	
			Longview Dolomite		250-450	
			Chepultepec Dolomite		725-880	
Middle & Upper Cambrian			Copper Ridge Dolomite		900-1000	
	Conasauga		Maynardville Limestone	418 - 450	Not Determined	1,500 (undivided)
			Nolichucky Shale	422 - 550		
			Maryville Limestone	346 - 445		
			Rogersville Shale	90 - 120		
			Rutledge Limestone	90 - 120		
			Pumpkin Valley Shale	260 - 320		
Lower Cambrian			Rome	Not Determined	Not Determined	800 +

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Figure 3-2. Stratigraphic Column of Bedrock Units in the Vicinity of the Y-12 Plant

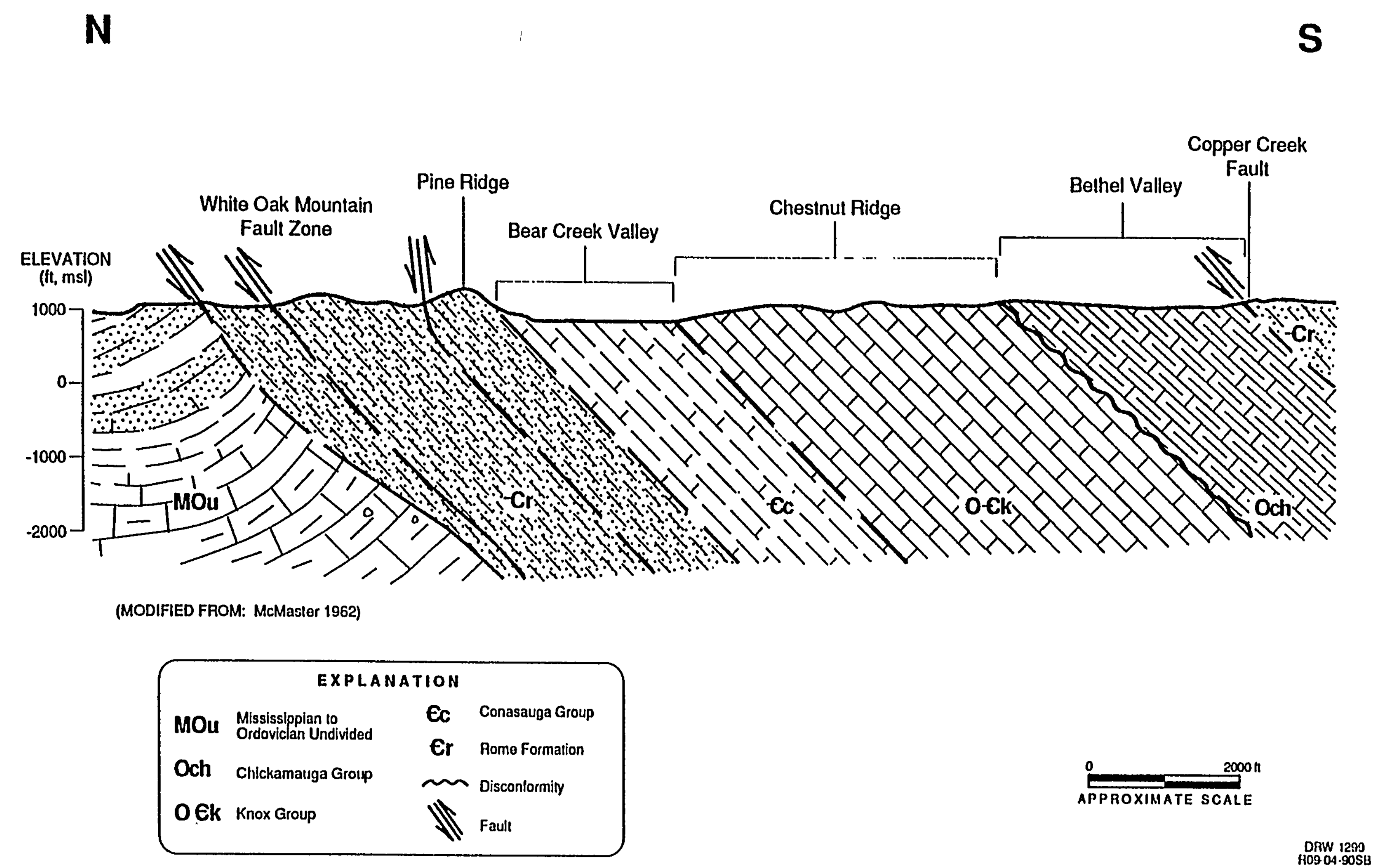


Figure 3-3. Geologic Cross-Section of the Y-12 Plant Area

highly variable (Sledz and Huff 1981; Ketelle and Huff 1984; Rothschild, Turner, et al 1984). Generally the studies identified one prominent joint set that roughly parallels the geologic strike. A second prominent set strikes slightly west of north and a third strikes nearly east-west. The majority of the dip directions are to the north.

The development of solution cavities in the Knox Group and the carbonate units of the Conasauga Group has been enhanced by structural features. Joints, bedding planes, and other zones of weakness provide avenues along which dissolution can occur. Solution cavities commonly occur in the upper part of the saturated zone and may be partly to completely filled with water and/or clay and secondary calcite.

3.2 HYDROGEOLOGIC REGIMES

As discussed in Section 2.0, the surface and ground-water system at the Y-12 Plant may be subdivided into three Bear Creek hydrogeologic regimes; Bear Creek, UEFPC, and Chestnut Ridge. A separate regime for Pine Ridge is not defined because there are no waste-management units located on the ridge.

3.2.1 Upper East Fork Poplar Creek and Bear Creek Hydrogeologic Regimes

The UEFPC and Bear Creek hydrogeologic regimes are both located in BCV and consequently share similar hydrogeologic characteristics. For this reason, the discussion of the surface water and ground-water systems in each of the two hydrogeologic regimes are combined in the following sections.

3.2.1.1 Surface-Water System

The surface water system in BCV is comprised of UEFPC, Bear Creek and their tributaries. Headwaters of both creeks are located at the west end of the Y-12 Plant near the S-3 Site (Figure 2-1). The flow to UEFPC is derived almost exclusively from the Y-12

Plant storm drain system which collects runoff from approximately 893 acres including the Plant compound and surrounding hillsides. More than 95 percent of the flow to UEFPC is comprised of; (1) once-through non-contact sanitary cooling water, (2) rain runoff, (3) condensate from steam systems and air compression or cooling, and (4) cooling tower blowdown (Geraghty & Miller, Inc. 1989a).

Flow in UEFPC is regulated by the outflow of Lake Reality located at the far east end of the Y-12 Plant (Figure 2-1). Below Lake Reality, water in UEFPC flows northward through a water gap in Pine Ridge into the developed areas of Oak Ridge, and then southwest to its confluence with Poplar Creek. The average stream gradient is approximately 21 ft per mile (Union Carbide Corporation 1984).

Surface water to the west of the Y-12 Plant is drained by Bear Creek (Figure 2-1). The headwaters of Bear Creek are located near the west end of the Y-12 Plant. Bear Creek flows southwestward from its headwaters for approximately 4-1/2 miles, where it turns northward to flow into UEFPC about 6 miles upstream of the Clinch River. Bear Creek is fed by several small tributaries and springs. The trellis pattern of the tributaries is believed to represent the surface expression of joint and fracture patterns in the underlying strata (Geraghty & Miller, Inc. 1985).

In its upper reaches, Bear Creek follows a relatively straight course along geologic strike that lies very close to the contact between the Conasauga (Maynardville Limestone) and Knox Groups. The channel is formed in the shallow alluvium overlying the Manardville Limestone. The presence of solution cavities in the Maynardville Limestone in the upper part of the saturated zone proximal to Bear Creek has been documented during drilling (Geraghty & Miller, Inc. 1985). Due to the presence of this solution cavity system, Bear Creek is both an influent and effluent stream; in some reaches of the creek, water flows from the creek into the ground (effluent) whereas in other reaches of the creek, springs discharge water from the ground to the creek (influent). The elevation of the water-table in BCV and the water level in the creek govern the locations of influent and effluent reaches of the creek (Battelle Columbus Division 1987).

3.2.1.2 Ground-Water System

The hydrogeologic system in the UEFPC and Bear Creek hydrogeologic regimes can be conceptualized as a single interconnected aquifer with markedly different hydraulic properties which are attributable to contrasting lithologies and structural features. The aquifer generally is composed of an upper zone of weathered unconsolidated material overlying a lower bedrock zone. Although the unconsolidated zone is sometimes more permeable than the bedrock zone, there is no sharp discontinuity of permeability between them and both respond in the same general way in terms of water-level fluctuations and the ground-water flow directions.

A recent study conducted near the Oak Ridge National Laboratory (Moore 1988) presents evidence that the rooted zone just below the land surface may be the location of significant ground-water movement. Moore's theory is based upon the idea that the permeability of the rooted zone is many times greater than the permeability of the underlying clayey residuum, thereby creating a thin near-surface "stormflow" zone one to two meters thick in which transient lateral ground-water flow occurs following precipitation events and lasting for only short periods of time. Moore states that as much as 90 to 95 percent of all ground-water flow in the residuum may occur in the stormflow zone (Moore 1988).

The physical and regulatory impacts of ground-water flow in the stormflow zone are not well defined at this point in time. Prior to the implementation of a stormflow monitoring program, studies of the implications for potential contaminant transport need to continue. Each regulated unit should be addressed as to the potential that releases from these units may be affected by ground-water flow in the stormflow zone.

3.2.1.2.1 Aquifer Components

Ground water in the unconsolidated zone occurs in residuum, alluvium, colluvium, and man-made fill. Because of the extensive re-working of the land surface associated with construction of the Y-12 Plant, man-made fill is especially predominant in the UEFPC Watershed. The fill material is generally more permeable than the surrounding residuum and provides conduits for water transport in the upper unconsolidated zone (Battelle Columbus Division 1987). It is not certain to what degree the re-worked land surface underlying the Y-12 Plant has affected surface water and ground-water interactions.

Due to the location of the waste-management units and the nature of the flow system underlying these units, two bedrock components of the aquifer system underlying the UEFPC and Bear Creek hydrogeologic regimes are of particular interest with respect to ground-water monitoring at the Y-12 Plant. These components are; (1) the primary shale formations of the Conasauga Group (Maryville Limestone and the Nolichucky Shale), and (2) the Maynardville Limestone.

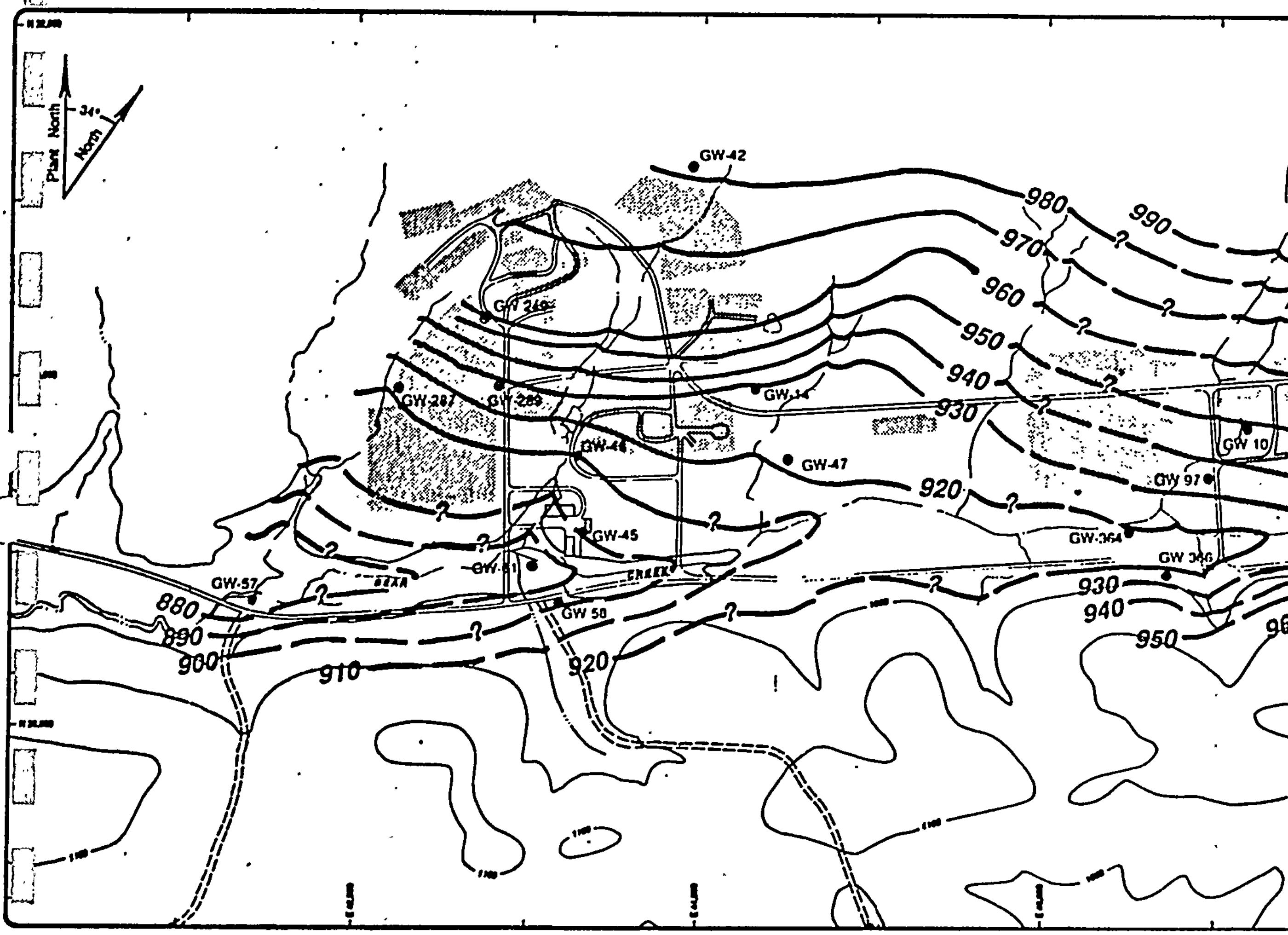
Many of the waste-management units located in the UEFPC and Bear Creek hydrogeologic regimes are underlain by either the Maryville Limestone (which, in the Oak Ridge area, is comprised predominantly of shale interbedded with limestone) the Nolichucky Shale, or both. Aquifer pumping tests conducted to determine the hydraulic properties of these formations have been typified by very low yields (usually less than five gallons per minute) and ellipsoidal water-level cones of depression, elongated parallel to geologic strike (Geraghty & Miller, Inc. 1986). These observations have been interpreted by several investigators to reflect the low permeability and strong anisotropy of the formations where bedding planes provide preferred ground-water flow paths along strike and down dip.

Several waste-management units located in the UEFPC and Bear Creek hydrogeologic regimes are underlain by the Maynardville Limestone, which is the principal water-bearing formation within the Conasauga Group in BCV. The water-bearing capacity of the Maynardville has been greatly enhanced by solution-enlargement of structural and stratigraphic features such as fractures, joints, and bedding planes. Evidence of the solution cavity system in the Maynardville can be observed in outcrops in Bear Creek and documented from drilling logs. Results of hydrogeologic packer testing of core holes indicate that this solution cavity system is the major discharge area for shallow and intermediate-depth ground water within the primary shale formations of the Conasauga Group (King & Haase 1988).

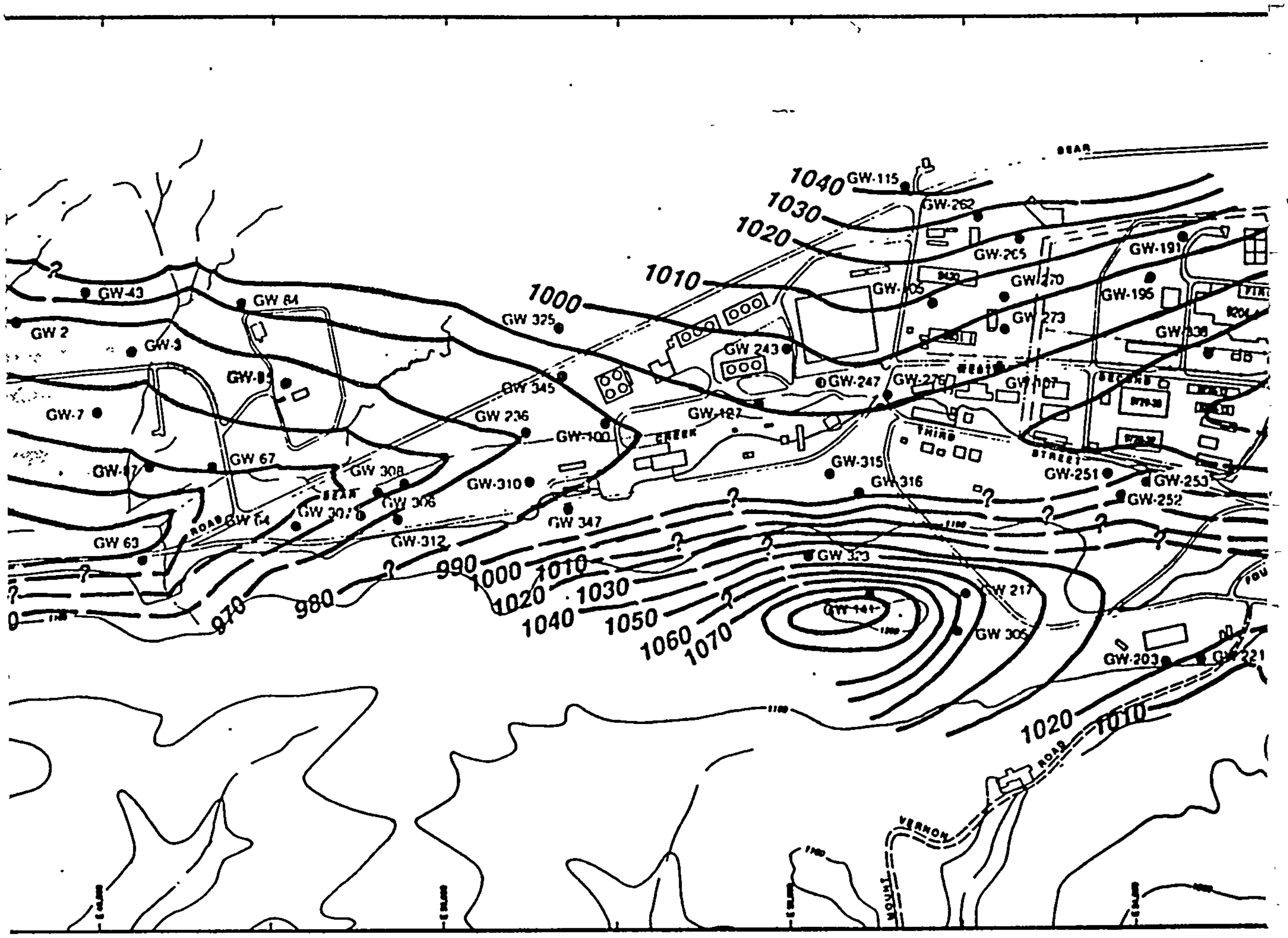
3.2.1.2.2 Flow Patterns

Generalized representations of horizontal and vertical ground-water flow patterns at the Y-12 Plant are presented on Figures 3-4 and 3-5, respectively. It must be emphasized that the flow patterns illustrated on these figures are conceptual and are not intended as actual depictions of the ground-water flow system.

The direction of ground-water flow in BCV is generally towards the two creeks that drain the valley; UEFPC and Bear Creek (Figure 3-4). Water level elevation data indicate that a ground-water flow divide is located in BCV near the west end of the Y-12 Plant. Northeast of the divide, ground-water flows towards UEFPC and southwest of the divide, ground-water flows towards Bear Creek. Studies have shown that the solution cavities in the Maynardville Limestone, which underlies these creeks throughout most of BCV, are the major discharge areas for shallow and intermediate depth ground-water moving through the primary shale formations of the Conasauga Group (King & Haase 1988). Ground-water



Plant North
North
34°
GW-42
980
990
970
960
950
940
930
920
GW-287
GW-289
GW-14
GW-44
GW-47
GW 10
GW 97
GW-364
GW-45
GW-51
GW-57
GW 50
BEAR
CREEK
880
890
900
910
920
930
940
950



1040
1030
1020
1010
1000
990
980
970
1050
1060
1070
GW-115
GW-262
GW-265
GW-191
GW-270
GW-196
GW-273
GW-43
GW 84
GW 2
GW-3
GW-7
GW 67
GW 63
GW 325
GW 243
GW 345
GW 236
GW-100
GW-310
GW 347
GW-312
GW-247
GW-276
GW-187
GW-315
GW 316
GW-251
GW-253
GW-252
GW 323
GW 217
GW 305
GW-203
GW 308
GW 306
CREEK
THIRD
STREET
WEST
ROAD
VERNON
MOUNT

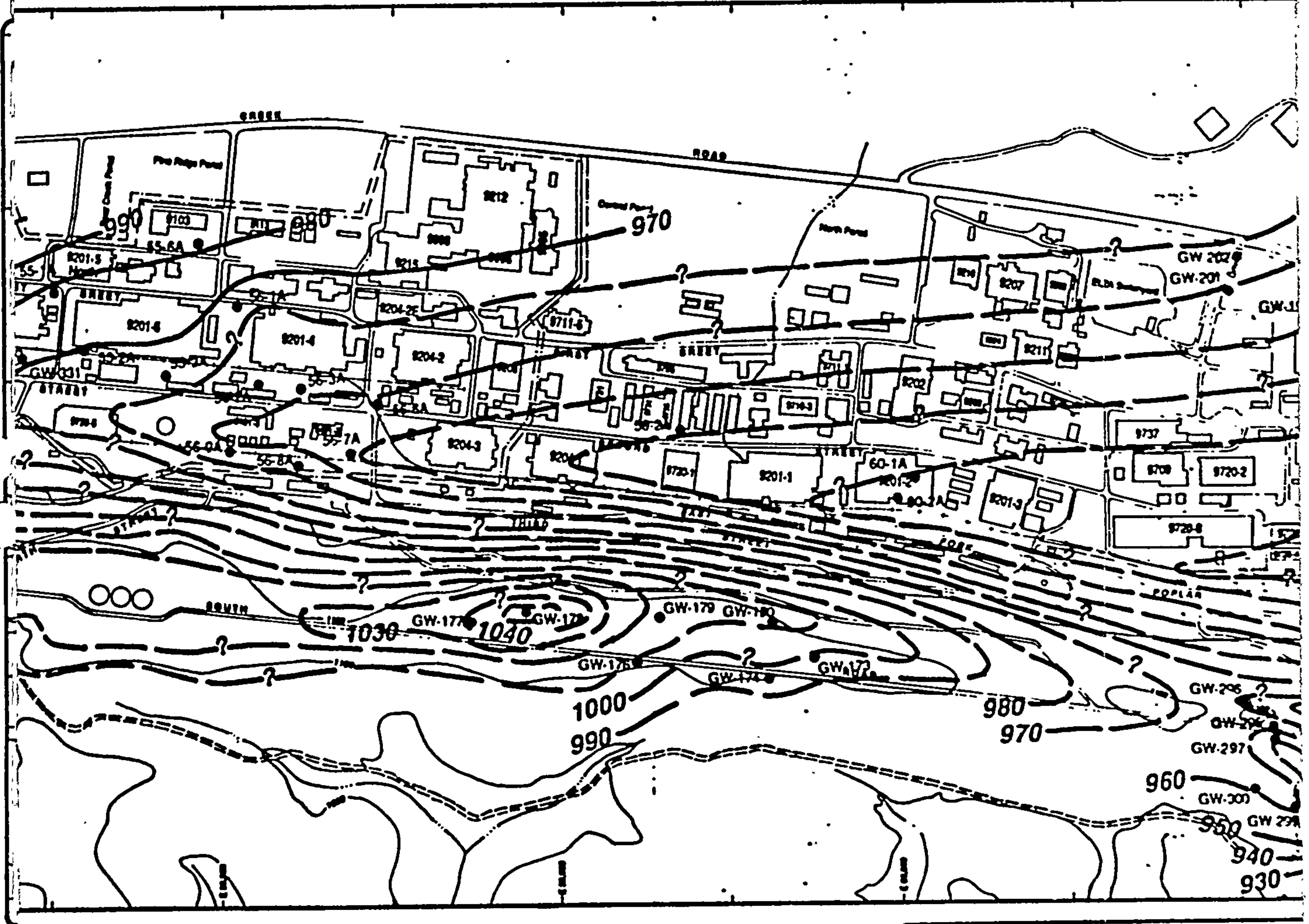
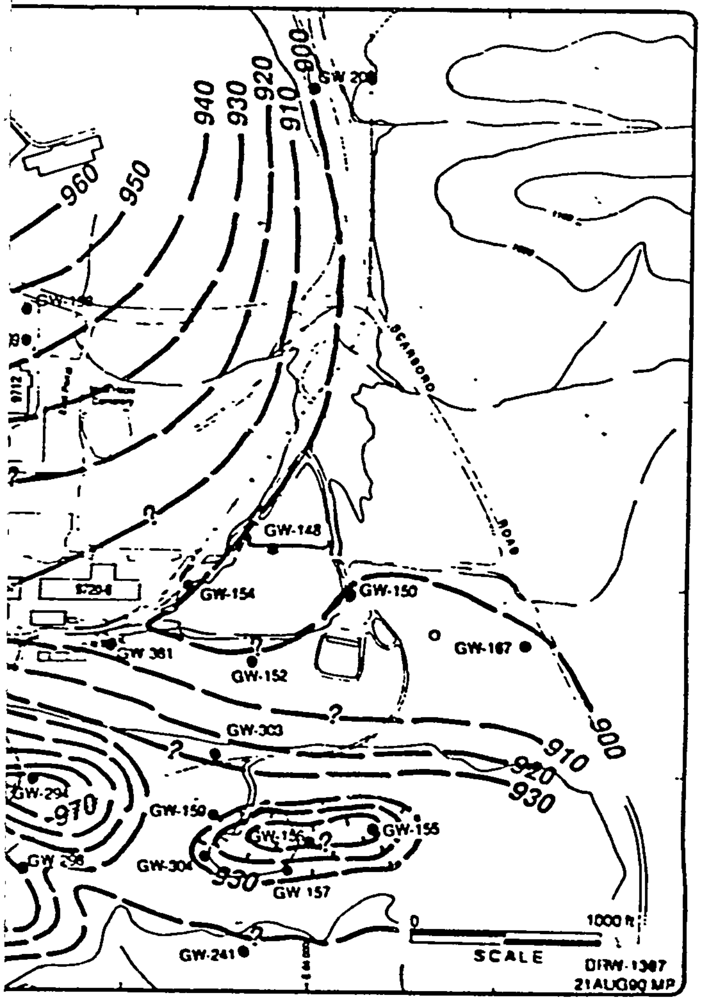
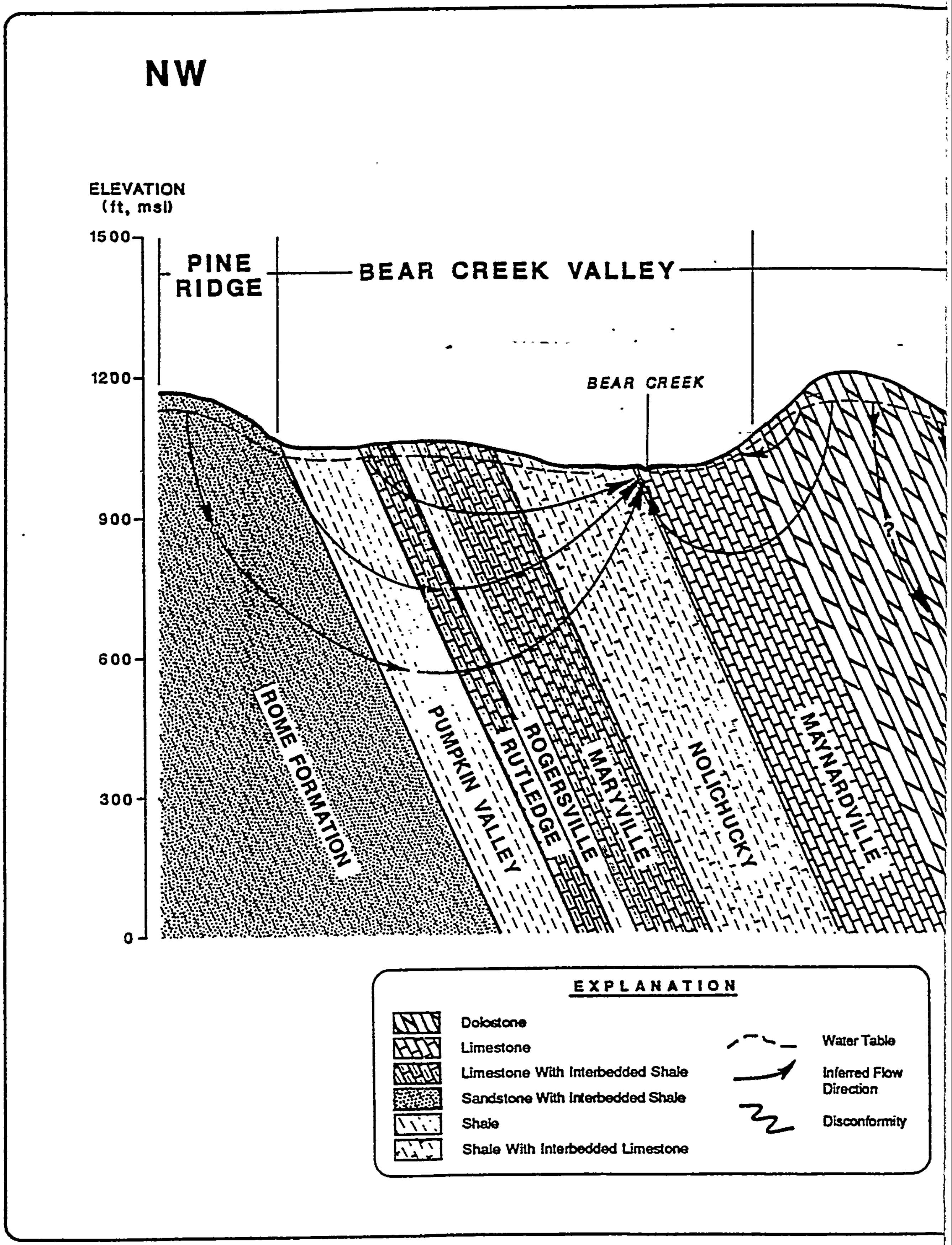


Figure 3-4. Water-Table Ele
from Averaged Water-L



ivation Contours at the Y-12 Plant as Determined
evel Measurements Observed from 1984-1988


NW
ELEVATION (ft, msl)
1500
1200
900
600
300
0
PINE RIDGE
BEAR CREEK VALLEY
BEAR CREEK
ROME FORMATION
PUMPKIN VALLEY
RUTLEDGE
ROGERSVILLE
MARYVILLE
NOLICHUCKY
MAYNARDVILLE
?
EXPLANATION
Dolostone
Limestone
Limestone With Interbedded Shale
Sandstone With Interbedded Shale
Shale
Shale With Interbedded Limestone
Water Table
Inferred Flow Direction
Disconformity

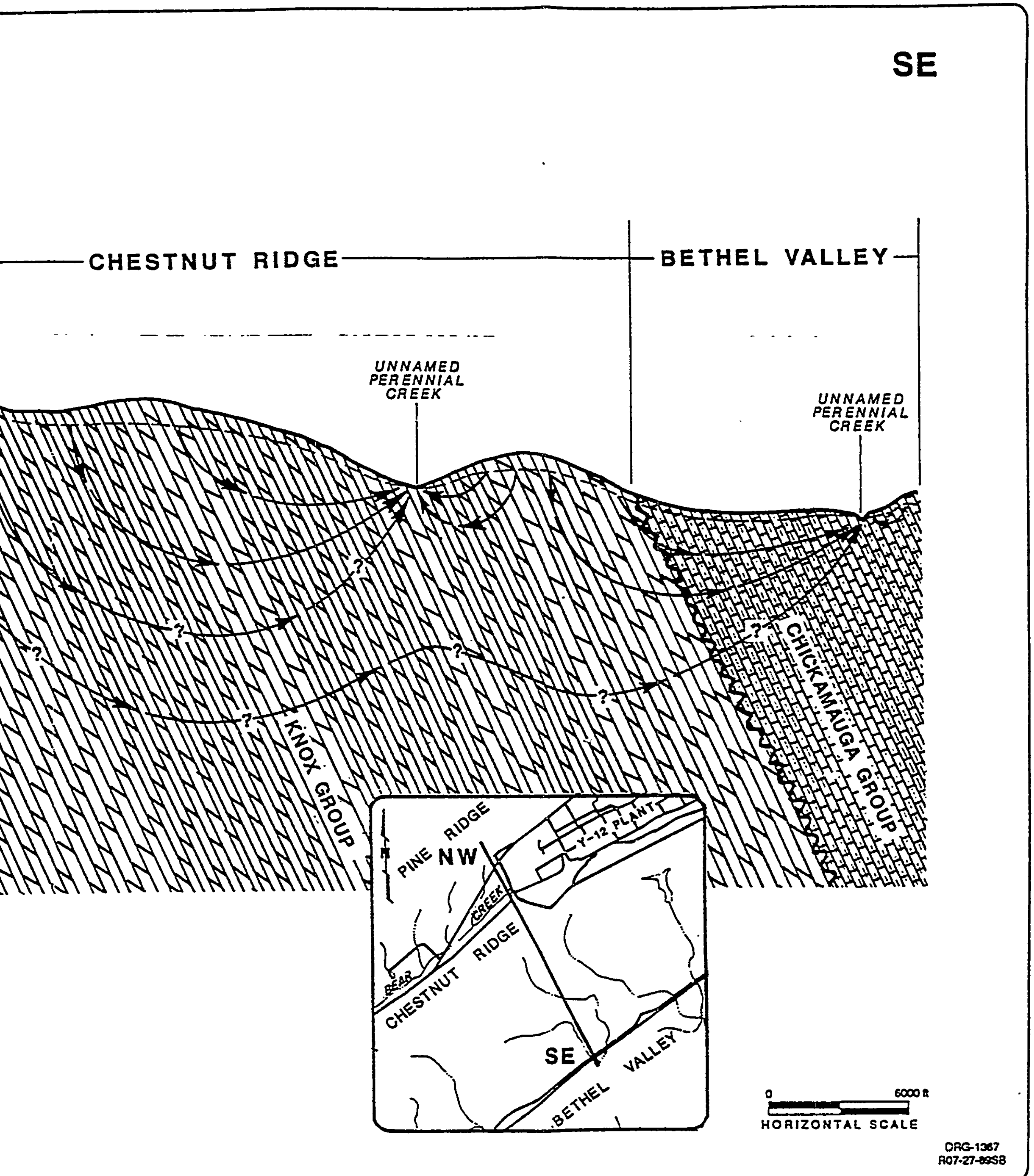


Figure 3-5. Cross-Sectional View of Conceptual Ground-Water Flow Patterns at the Y-12 Plant

discharge from the Maynardville sustains the flow of Bear Creek, or at times of low flow, moves through the solution cavities underlying Bear Creek (Geraghty & Miller, Inc. 1985). The hydrologic relationship between the Maynardville Limestone and UEFPC is less well understood due to the primary focus of previous hydrogeologic studies on the Bear Creek hydrogeologic regime and the pronounced influence of water discharged from the plant.

Upward components of ground-water flow are commonly observed in wells screened below 50 ft in the Maryville and Nolichucky formations, as expected from the conceptualization on Figure 3-5. Downward components of flow have been noted within the Maynardville Limestone between depths of 40 and 200 ft near the headwaters of Bear Creek.

3.2.2 Chestnut Ridge Watershed

3.2.2.1 Surface-Water System

Most of the waste-management units on Chestnut Ridge are generally located to the south and southwest of the Y-12 Plant. Surface water runoff from the vicinity of these sites flows to the north down the ridge flank into the UEFPC and Bear Creek hydrogeologic regimes, and to the south into the watersheds of three tributaries to the Clinch River; Walker Branch, McCoy Branch, and Tributary No. 4 (Figure 2-1). In addition to the surface runoff, flow in these tributaries is also sustained by ground-water discharge through springs located in the stream beds.

Watersheds of McCoy Branch and Tributary No. 4 were the subject of a hydrologic study performed by the United States Geological Survey (USGS) in 1984. As part of the study, instantaneous discharge and specific conductance measurements were collected at selected sites in each watershed (Evaldi 1984). Results of the study indicated that, like

Bear Creek in BCV, McCoy Branch and Tributary No. 4 each contain effluent and influent reaches. Flow data indicated that influent sections of McCoy Branch are located in the vicinity of four springs which discharge to the creek, and effluent sections of the creek are present downstream of these springs. Flow data for Tributary No. 4 indicated that effluent sections of the stream are located above an elevation of 820 ft.

3.2.2.2 Ground-Water System

Unlike the hydrogeologic system underlying BCV, the unconsolidated materials on Chestnut Ridge are generally unsaturated and ground water usually occurs under water-table conditions in the bedrock formations of the Knox Group.

3.2.2.2.1 Aquifer Components

The unconsolidated (unsaturated) zone on Chestnut Ridge does not usually contain significant amounts of ground water. Downward percolation of water through the unsaturated zone occurs at a rate that is controlled by vertical permeability. Because of the high clay content of the residuum, the permeability of these materials is primarily due to secondary openings, such as chert-rich zones, which provide conduits for recharge to the underlying water table in the Knox Group (Geraghty & Miller, Inc. 1989b).

The Knox Group consists primarily of fractured and jointed dolostones that, like the limestones in the Maynardville in BCV, have been subjected to considerable dissolution by circulating ground water. Dissolution along fractures, joints, and bedding planes is predominantly responsible for the porosity and permeability of the formation. Thus, ground-water movement within the Knox Group is largely restricted to these solution-enlarged conduits. However, after storm events a stormflow zone may develop in which significant volumes of transient lateral ground-water flow may occur in the upper 1 to 2 meters of land surface in the rooted zone (Moore 1988).

The significance of conduits has been substantiated by packer tests conducted on Chestnut Ridge in three core holes aligned approximately along geologic strike. Test intervals within the core holes were selected to correspond with fractured or solutionally altered zones, unaltered sections, or intervals associated with geophysical anomalies. Results of these tests indicated that lower permeability values generally correlate to unaltered sections of rock, whereas higher values usually represented fractured and/or karstic intervals (Golder and Associates 1987a; 1987b and King & Haase 1988).

3.2.2.2.2 Flow Patterns

A conceptualization of the hydrogeologic system underlying Chestnut ridge, as would be expected in an isotropic and homogeneous system, is provided on Figure 3-5. As shown, a ground-water flow divide is located approximately beneath the ridge crest. The location of the divide influences whether ground water flows northwest into the Bear Creek and UEFPC watersheds or southeast toward watersheds in Bethel Valley. Actual ground-water flow behavior undoubtedly departs from this conceptualization because of the influence of bedding orientation and secondary openings, such as fractures, joints, and solution cavities.

The distribution of joints, fractures, and solution cavities exert substantial local influence on ground-water flow directions in the Knox Group (Ketelle and Huff 1984). Studies of the joint and fracture patterns on Chestnut Ridge suggest that preferred ground-water flow directions within the upper Knox Group are parallel with and perpendicular to the ridge crest (Law Engineering Testing Company 1983).

Springs and stream tributaries are the discharge points for ground water in the Knox Group, as shown on Figure 3-5. Numerous springs have been observed along the northwestern flank of Chestnut Ridge near the contact between the Maynardville Limestone and the Knox Group. It is likely that some of the ground water from the Knox is discharged to the Maynardville Limestone in BCV (Figure 3-1); however, the degree of hydraulic communication between the Knox and the Maynardville has not been fully determined. Topographic maps of the area also note the presence of springs and perennial stream tributaries along the southeastern flank of Chestnut Ridge. The base flow of the tributaries is probably sustained by ground-water discharges from the Knox Group. In addition, ground water following deeper flow paths in the Knox may discharge to streams and tributaries in Bethel Valley.

4.0 REGULATORY REQUIREMENTS FOR GROUND-WATER MONITORING

The following sections provide an overview of the types of waste management sites at the Y-12 Plant, and the requirements for ground-water monitoring programs mandated by applicable state and federal regulations, DOE orders, and guidelines. A concluding section outlines in detail how compliance with all applicable requirements will be achieved and maintained.

4.1 TYPES OF WASTE-MANAGEMENT SITES

There are over 100 sites at the Y-12 Plant at which hazardous or non-hazardous wastes are presently or have previously been managed. The types of waste-management units include above and below-ground storage tanks, landfills, surface impoundments, waste piles, land treatment areas, and scrap yards. Several of these sites were operational for over 30 years. Furthermore, waste-management activities at many of the sites were initiated prior to the strict environmental laws enacted by Congress in the mid-1970s and early 1980s, and while many of these were responsibly operated in accordance with accepted industry practices of the time, many were not specifically designed or operated to prevent contaminant releases to the environment. Consequently, there now exists a large number of potential contaminant source areas at the Y-12 Plant.

4.1.1 Hazardous Waste Sites

Hazardous-waste management units at the Y-12 Plant are currently regulated under either the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response and Liability Act (CERCLA). Regulations governing implementation of RCRA TSD sites are contained in Parts 260 through 270 of Title 40, Code of Federal Regulations (40 CFR). The State of Tennessee RCRA regulations are contained in "Rules of the Tennessee Department of Health and Environment, Chapter 1200-1-11, Hazardous Waste Management." Federal regulations pertaining to CERCLA are contained in Subchapter J of 40 CFR; at this time, no corresponding TDHE regulations have been issued. Unlike the RCRA regulations, CERCLA regulations lack detailed requirements, and the implementation of CERCLA is consequently more dependent upon EPA guidance documents.

4.1.1.1 Interim Status RCRA Sites

When the EPA first issued regulations to implement RCRA, it was recognized that all the hazardous-waste TSD facilities throughout the country could not be permitted simultaneously and that facilities in operation prior to the enactment of RCRA could not be expected to immediately comply with RCRA standards. The regulations therefore established an interim status period to allow time for owners/operators to bring their TSD facilities into compliance with RCRA.

There are eight land-based disposal units at the Y-12 Plant which have been granted interim status (Table 4-1). RCRA Part B post-closure permit applications (PCPAs) have been submitted to the TDHE for the S-3 Ponds, Oil Landfarm, Bear Creek Burial Grounds (Geraghty & Miller, Inc. 1988a, 1988b, and 1988c), New Hope Pond (Lee Wan and Associates, Inc. 1989a), the Chestnut Ridge Security Pits (Geraghty & Miller, Inc. 1989), and the Chestnut Ridge Sediment Disposal Basin (Lee Wan and Associates, Inc. 1989b). PCPAs for the remaining interim status sites (Table 4-1) are currently being prepared. The location of each of these sites is shown on Figure 4-1. As shown, one site (New Hope Pond) is located in the UEFPC watershed near the east end of the Y-12 Plant, three sites (S-3 Site, Oil Landfarm, and Bear Creek Burial Grounds) are located in the Bear Creek hydrogeologic regime west of the Y-12 Plant and comprise the the Bear Creek Valley Waste Disposal Area (BCVWDA), three sites (Chestnut Ridge Security Pits, Chestnut

Table 4-1. RCRA Regulated Hazardous-Waste Treatment, Storage, and Disposal Sites at the Y-12 Plant

Site Location and Name	Interim Status Monitoring Programs						Permit Required Monitoring		
	Detection Monitoring	Assessment Monitoring					Detection Monitoring	Compliance Monitoring	Corrective Action Monitoring
		GWQAP	GWQARs 1986	1987	1988	1989			
Bear Creek Watershed									
S-3 Waste-Management Area *(a)*	N/A	Dec-1986	x	x	x	*(b)*	N/A	TBD *(d)*	TBD *(d)*
Oil Landfarm Waste-Management Area	N/A	Dec-1986	x	x	x	*(b)*	N/A	TBD *(d)*	TBD *(d)*
Bear Creek Burial Grounds Waste-Management Area	N/A	Dec-1986	x	x	x	*(b)*	N/A	TBD *(d)*	TBD *(d)*
UEFPC Watershed									
New Hope Pond	Jan-1986	Jan-1988	—	—	x	*(c)*	N/A	TBD *(d)*	TBD *(d)*
Chestnut Ridge									
Chestnut Ridge Sediment Disposal Basin	Jan-1986	—	—	—	—	—	x	TBD *(e)*	—
Chestnut Ridge Security Pits	Jan-1986	Jan-1988	—	—	x	—	N/A	TBD *(d)*	TBD *(d)*
East Chestnut Ridge Waste Pile	Sep-1987	—	—	—	—	—	x	TBD *(e)*	—
Kerr Hollow Quarry	Jan-1986	—	—	—	—	—	N/A *(f)*	TBD *(f)*	N/A *(f)*

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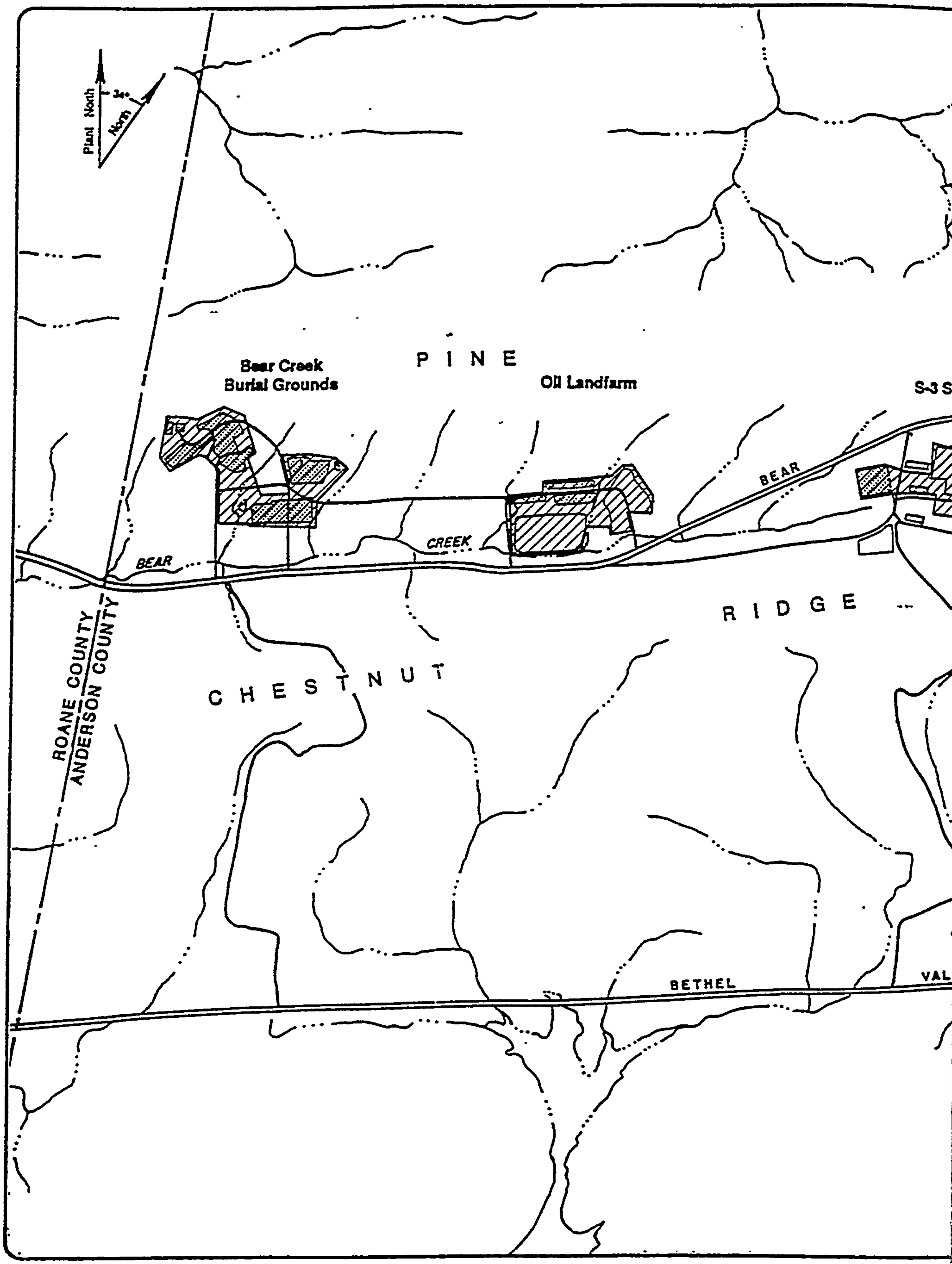
UEFPC = Upper East Fork Poplar Creek
GWQAP = Ground-Water Quality Assessment Plan
GWQAR = Ground-Water Quality Assessment Report
TBD = To be determined
N/A = Not Applicable
X = Completed

(a) = Extends into UEFPC Hydrogeologic Regime
(b) = To be included in GWQAR for Bear Creek Hydrogeologic Regime
(c) = To be included in GWQAR for UEFPC Hydrogeologic Regime
(d) = Currently under negotiation.
(e) = Dependent upon detection monitoring results.
(f) = Site will be clean-closed; no monitoring required



Plant North
North
34°
Bear Creek
Burial Grounds
PINE
Oil Landfarm
S-3 SI
BEAR
CREEK
BEAR
RIDGE
CHESTNUT
ROANE COUNTY
ANDERSON COUNTY
BETHEL
VAL

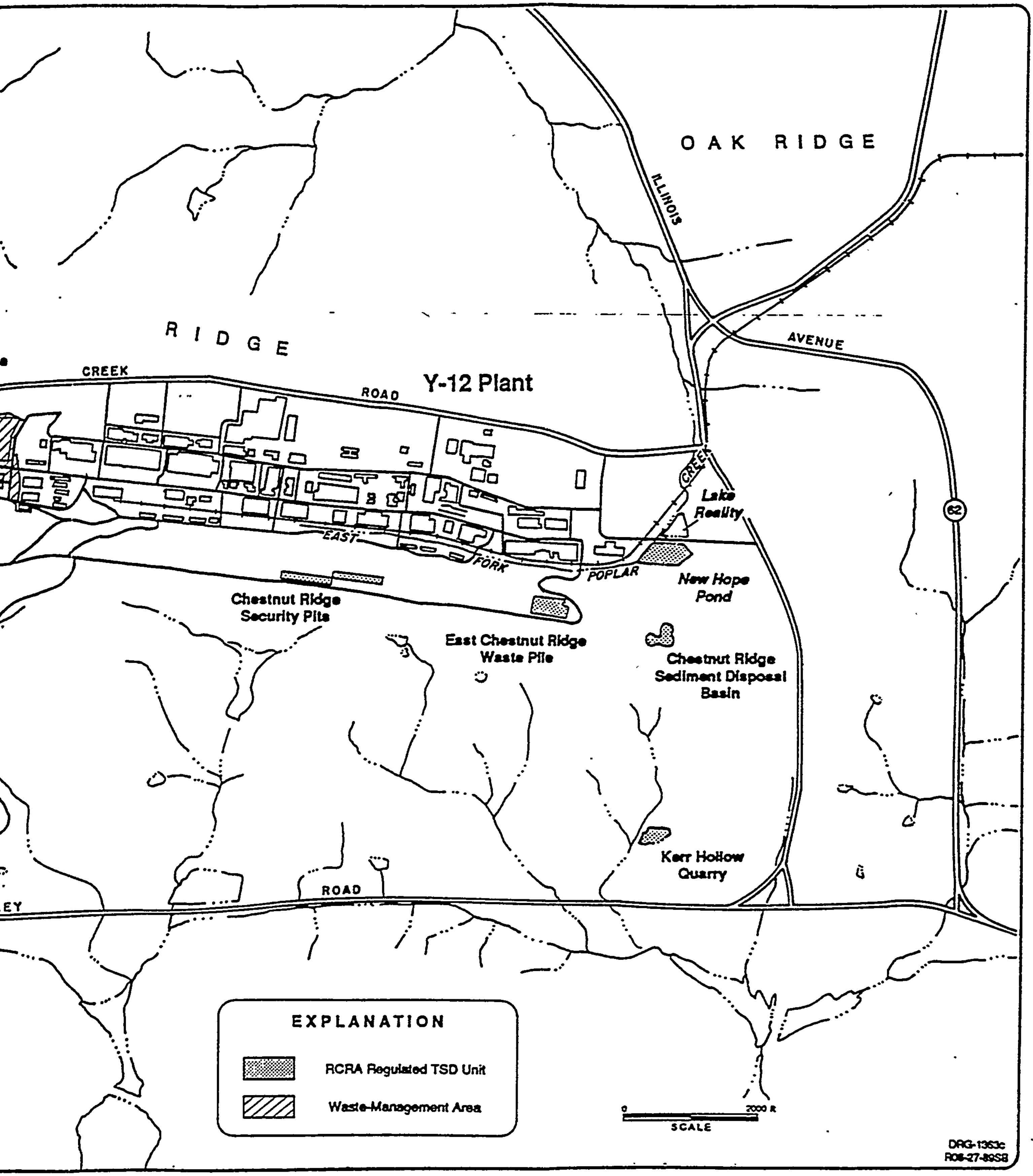


Figure 4-1. Location of RCRA Interim Status TSD Units at the Y-12 Plant

Ridge Waste Pile, Chestnut Ridge Sediment Disposal Basin) are located on Chestnut Ridge, and one site (Kerr Hollow Quarry) is located in Bethel Valley.

4.1.1.2 Permitted RCRA Sites

Unless exempt from permitting requirements, RCRA hazardous-waste Part B permits must be obtained for all new TSD units (operating permits), and interim status units which were not closed by January 26, 1983 (post-closure permits). At this time, operating permits have been obtained for several hazardous-waste treatment and storage facilities at the Y-12 Plant, but no operating or post-closure permits have been issued for any land-based hazardous-waste disposal unit at the Plant.

4.1.1.3 RCRA Solid Waste Management Units

Congress passed the Hazardous and Solid Waste Amendments (HSWA) to RCRA in November 1984. In general, the HSWA significantly expanded both the scope and coverage of RCRA (Arbuckle, et al 1985). Under Section 3004(u) of HSWA, any facility applying for a RCRA Part B permit is subject to an assessment of all solid waste-management units (SWMUs) located at the facility. The HSWA define a SWMU as:

"Any discernible waste-management unit at a RCRA facility from which hazardous constituents might migrate, irrespective of whether the unit was intended for the management of solid and/or hazardous waste: (U.S. Environmental Protection Agency 1986)."

This definition does not include accidental spills from production areas, and units in which wastes have not been managed (e.g., product storage areas) (U.S. Environmental Protection Agency 1986).

Since early 1987, efforts to identify all SWMUs at the Y-12 Plant have been in progress. In April of that year, Energy Systems issued a report entitled "Solid Waste Management Unit Information for Y-12 Plant RCRA 3004(u) Facility Assessment (RFA)"which listed many of the SWMUs associated with the Y-12 Plant (Welch, et al 1987). In 1987, 1988, and 1989, supplemental RFA documents were prepared by Energy Systems which listed additional SWMUs located at the Y-12 Plant (Welch 1987; Wiggins and Welch 1988a, 1988b; Murphy 1989). A list of all the SWMUs for which some degree of contaminant release investigation is currently in progress or is planned is provided on Table 4-2; Locations of these SWMUs are shown on Figure 4-2 (Bear Creek Valley) and Figure 4-3 (UEFPC hydrogeologic regime and Chestnut Ridge).

4.1.1.4 CERCLA Sites

In May 1985, DOE issued Order 5480.14 defining how CERCLA was to be implemented at all DOE installations, with the exception of those facilities designated for remedial action under the Formerly Utilized Sites Remedial Action Project, the Uranium Mill Tailings Remedial Action Project, the Grand Junction Remedial Action Project, and the Surplus Facilities Management Program (H&R Technical Associates, Inc. 1988). A preliminary listing of all the sites at the Y-12 Plant which were subject to the DOE CERCLA program was prepared in 1986 but since that time, a number of those sites have been re-classified as SWMUs and releases from these sites will be addressed under RCRA section 3004(u) (H&R Technical Associates, Inc. 1988). Sites still currently regulated under DOE CERCLA are listed on Table 4-3. The locations of the DOE CERCLA sites at the Y-12 Plant are shown on Figure 4-4.

In July 1989 the EPA proposed that the entire Oak Ridge Reservation be placed on the National Priorities List (NPL). The impact of this listing has not been defined at this time; however, it is conceivable that corrective actions deemed appropriate for the RCRA

Table 4-2. RCRA Solid Waste-Management Units at the Y-12 Plant

SWMU Name	SWMU Number	Status of RFI Plan: Scheduled	Status of RFI Plan: Submitted to EPA	Status of RFI Plan: Revised	Approved by EPA	Media to be addressed: Soil	Media to be addressed: Ground Water	Media to be addressed: Surface Water
Bear Creek Watershed								
Oil Retention Pond No. 1	T-008 *(a)*	—	—	—	—	—	—	—
Oil Retention Pond No. 2	T-009 *(a)*	—	—	—	—	—	—	—
Haz. Chem. Storage Area Boneyard/Burnyard	D-024-HC *(b)*	—	—	—	—	—	—	—
Sanitary Landfill I	D-102 *(b)*	—	—	—	—	—	—	—
Rust Spoil Area	D-106	—	1987	1989	—	X	X *(e)*	*(g)*
Spoil Area 1	D-107	—	1987	1989	—	X	X *(e)*	*(g)*
SY-200 Yard	S-123	—	1989	—	—	X	X *(e)*	*(g)*
UEFPC Watershed								
S-2 Site	D-103 *(c)*	—	1987	1989	—	X	X *(f)*	*(h)*
Coal Pile Trench	D-104	TBD	—	—	—	—	—	—
9418 Uranium Vault	D-115	—	1987	—	—	X	X *(f)*	*(h)*
Bldg 9409-5 Storage Facility	S-017	TBD	—	—	—	—	—	—
Salvage Yard Oil Storage Area	S-018 *(c)*	—	1987	1989	—	X	X *(f)*	*(h)*
Salvage Yard Oil/Solvent Drum Storage	S-020 *(c)*	—	1987	1989	—	X	X *(f)*	*(h)*
Interim Drum Yard	S-030 *(c)*	TBD *(d)*	—	—	—	—	—	—
Salvage Yard Scrap Metal Storage Area	S-111 *(c)*	—	1987	—	—	X	X *(f)*	*(h)*
Bldg 81-10 Area	S-117	—	1988	—	—	X	X *(f)*	—
Line Yard (West of 9720-8)	S-120	—	1987	1989	—	X	—	—
Waste Z-Oil Tank (Bldg 9419-9)	S-121	—	1987	—	—	X	—	—
Dock 164 (Bldg 9808)	S-313	TBD	—	—	—	—	—	—
9201-1 West Yard	S-321	TBD	—	—	—	—	—	—
9401-2 Poly Tank Station	S-334	—	1988	—	—	X	—	—
9401-3 East Yard	S-335	TBD	—	—	—	—	—	—
Bldg 9712 Northeast Yard	S-338	TBD	—	—	—	—	—	—
9401-2 East Yard (Bldg 9720-29)	S-351	—	1988	—	—	X	—	—
Rust Construction Garage Area	S-400 *(c)*	TBD	—	—	—	—	—	—
Waste Coolant Processing Facility	T-038	—	1987	1989	—	X	X *(f)*	—
Salvage Yard Drum Deheader	T-109 *(c)*	—	1987	1989	—	X	X *(f)*	*(h)*
Nitric Acid Pipeline	?	1989	—	—	—	X	X *(f)*	—
Tank 2064-U	S-205	—	1987	—	—	X	X *(f)*	—
Tank 2063-U	S-204 *(c)*	—	1987	1989	—	X	X *(f)*	—
Tank 2101-U	S-210	—	1988	—	—	X	X *(f)*	—
Tank 2104-U	S-212	—	1988	—	—	X	X *(f)*	—
Tank 2105-U	S-213	TBD	—	—	—	—	—	—
Tank 2116-U	S-214	—	1988	—	—	X	X *(f)*	—
Bldg 9204-4 Tank (1)	S-215	TBD	—	—	—	—	—	—
Bldg 9204-4 Tank (2)	S-217	—	1988	—	—	X	X *(f)*	—
Bldg 9204-4 Tank (3)	S-218	—	1988	—	—	X	X *(f)*	—
Tank	S-225	TBD *(d)*	—	—	—	—	—	—
Bldg 9206 Tank (1)	S-227	TBD	—	—	—	—	—	—
Bldg 9206 Tank (2)	S-228	TBD	—	—	—	—	—	—
Chestnut Ridge								
Sanitary Landfill II	D-192	TBD	—	—	—	—	—	—
Filled Coal Ash Pond	D-112	—	1988	—	—	—	X	X
Temporary Storage Area	S-126	TBD	—	—	—			
Tank 2069-U	S-206	TBD	—	—	—	—	—	—
Tank 2070-U	S-207	TBD	—	—	—	—	—	—
Tank 2071-U	S-208	TBD	—	—	—	—	—	—

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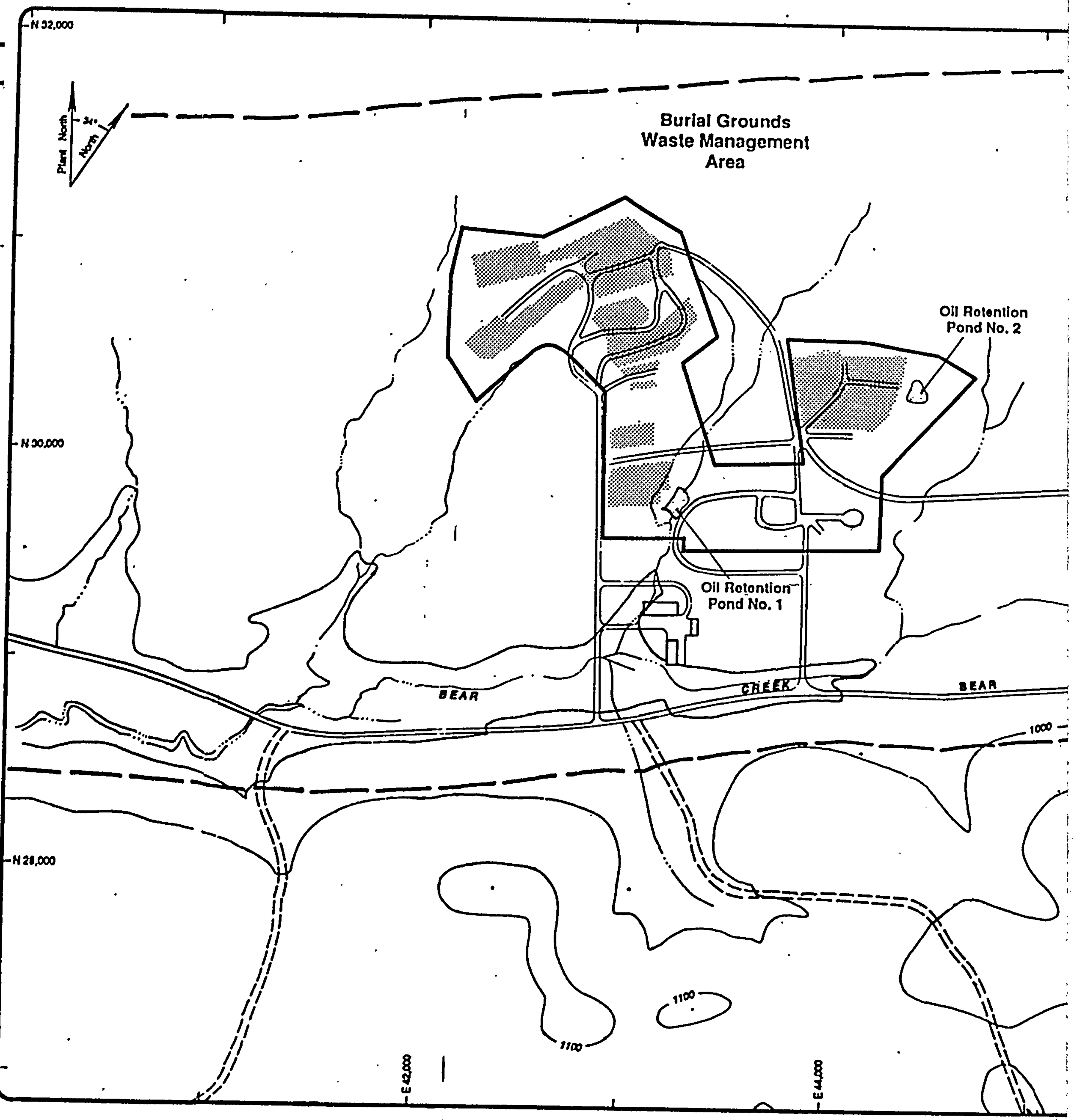
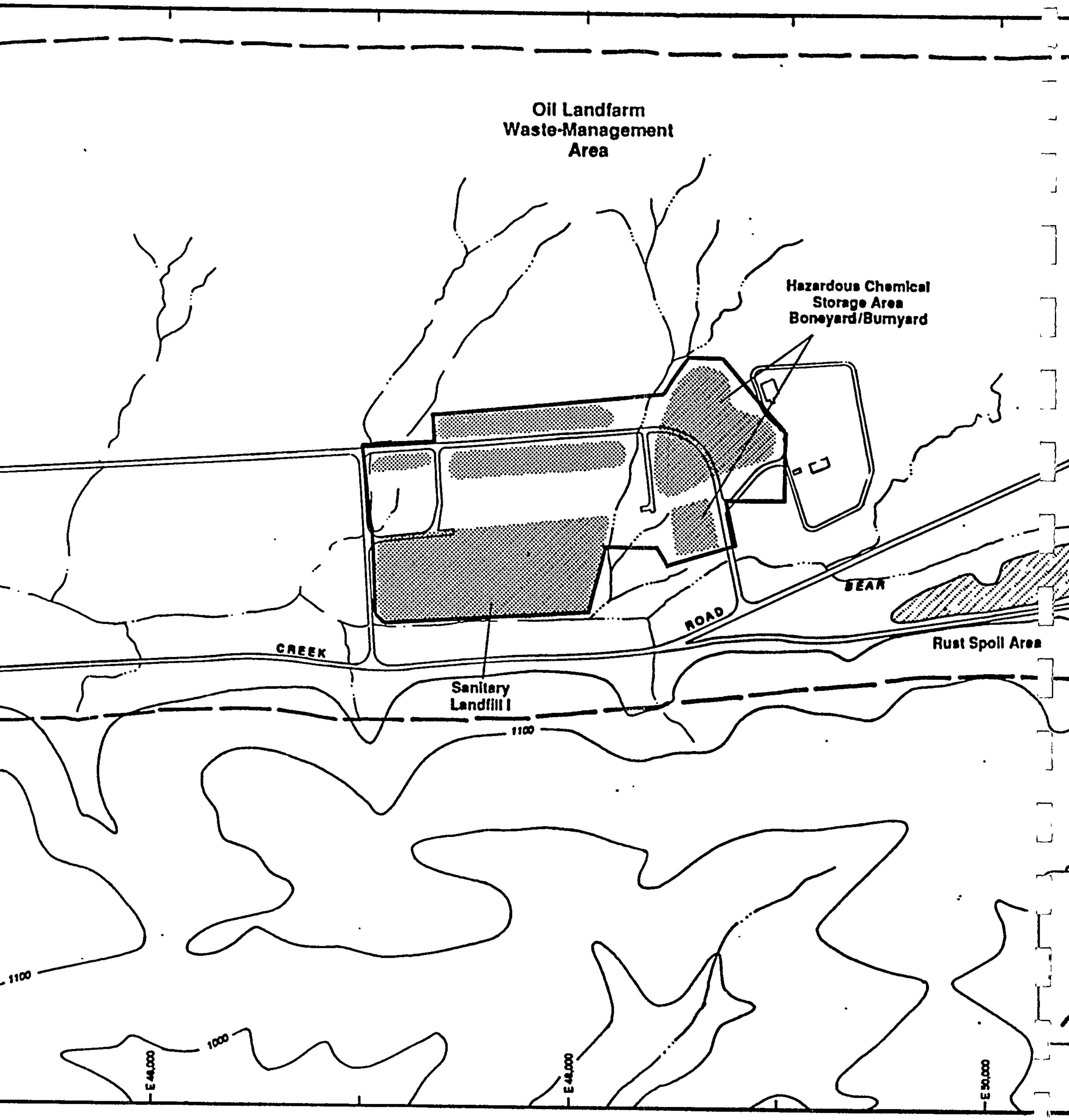
TBD - To Be Determined.
(a) Included in RCRA closure and investigation at the Bear Creek Burial Grounds
(b) Included in RCRA closure and investigation at the Oil Landfarm
(c) Included in S-3 Site Waste Management Area
(d) Tentative; final determination will be made at closure.
(e) Ground water investigation included in contamination assessment program for Bear Creek Hydrogeologic Regime
(f) Ground water investigation included in contamination assessment program for UEFPC Hydrogeologic Regime
(g) To be addressed under RFI for Bear Creek
(h) To be addressed under RFI for EFPC


N 32,000
Plant North
34°
North
Burial Grounds
Waste Management
Area
Oil Retention
Pond No. 2
N 30,000
Oil Retention
Pond No. 1
BEAR
CREEK
BEAR
1000
N 28,000
1100
1100
E 42,000
E 44,000



Oil Landfarm
Waste-Management
Area
Hazardous Chemical
Storage Area
Boneyard/Burnyard
BEAR
ROAD
CREEK
Rust Spoil Area
Sanitary
Landfill I
1100
1100
1000
E 46,000
E 48,000
E 50,000

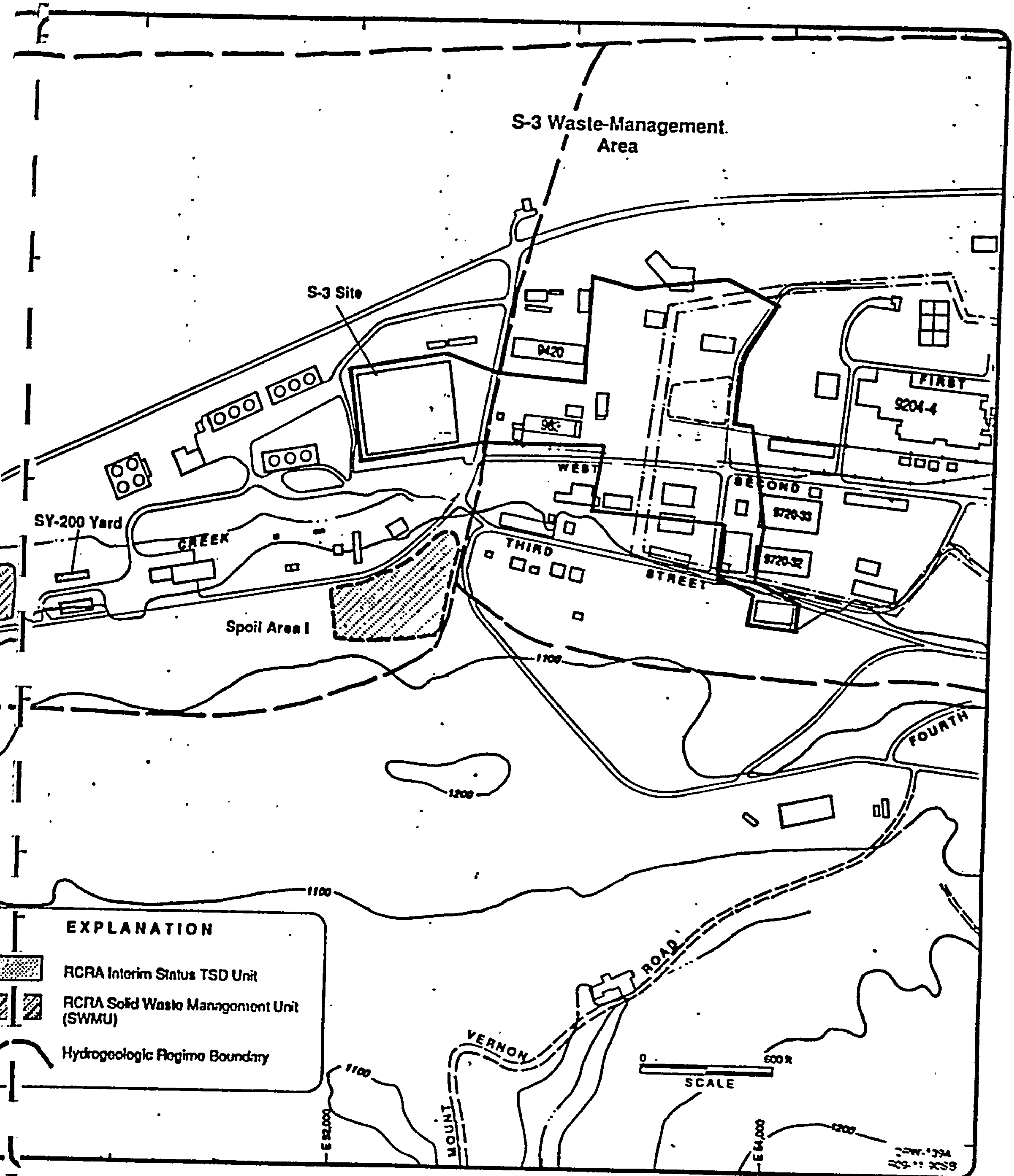
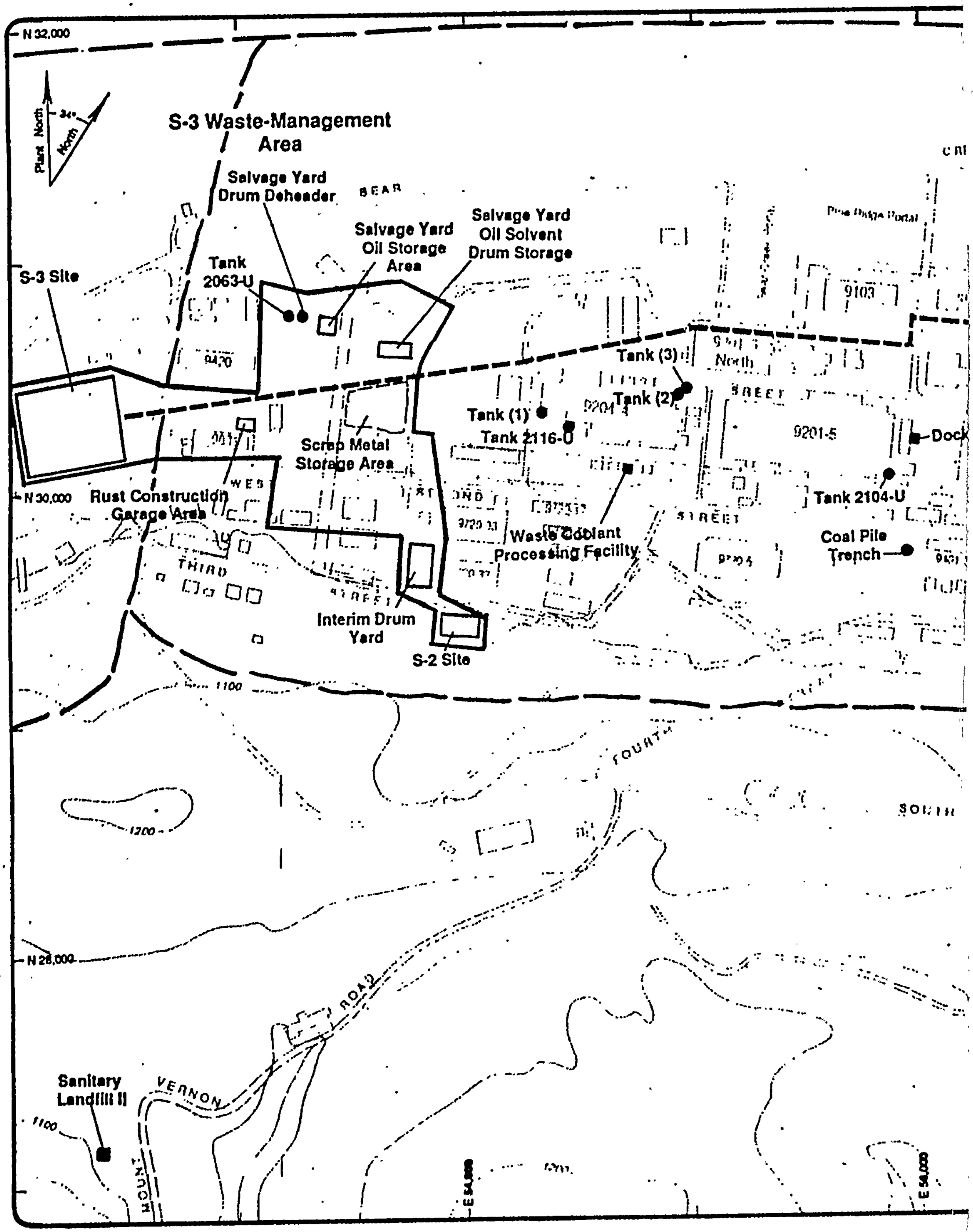
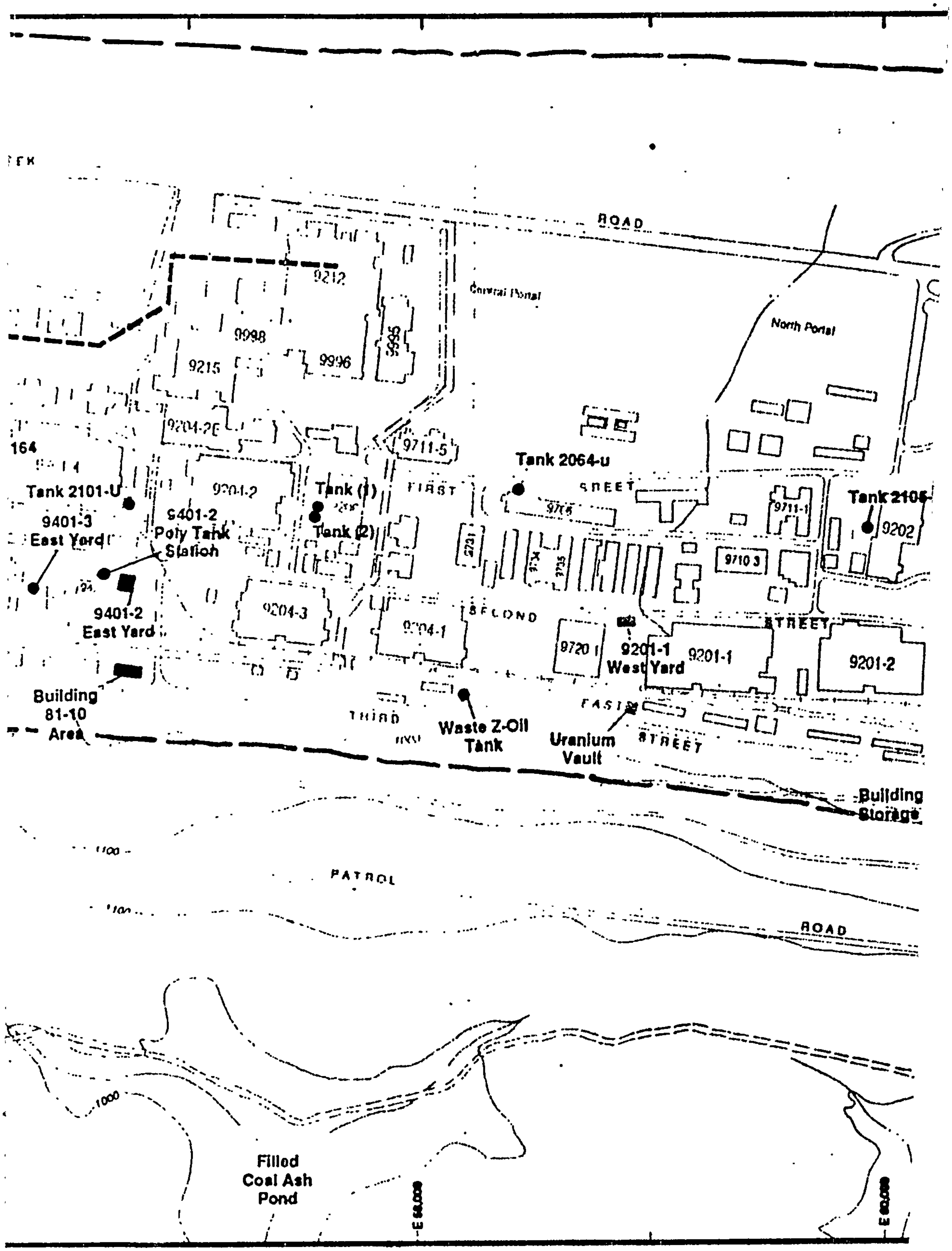


Figure 4-2. Location of RCRA SWMUs in the Bear Creek Hydrogeologic Regime



N 32,000
Plant North
34°
North
S-3 Waste-Management
Area
Salvage Yard
Drum Deheader
BEAR
Salvage Yard
Oil Storage
Area
Salvage Yard
Oil Solvent
Drum Storage
Pine Ridge Portal
S-3 Site
Tank
2063-U
9103
9720
Tank (3)
North
Tank (2)
9204
STREET
Tank (1)
Tank 2116-U
9201-5
Dock
Scrap Metal
Storage Area
N 30,000
Rust Construction
Garage Area
WEST
Tank 2104-U
STREET
Waste Coolant
Processing Facility
Coal Pile
Trench
THIRD
STREET
Interim Drum
Yard
S-2 Site
1100
FOURTH
SOUTH
1200
N 28,000
ROAD
Sanitary
Landfill II
VERNON
MOUNT
1100
E 54,000
E 56,000



ROAD
Central Portal
North Portal
9212
9998
9996
9995
9215
9204-2E
9711-5
164
Tank 2064-u
Tank 2101-U
9201-2
Tank (1)
Tank (2)
FIRST
STREET
9766
9711-1
Tank 2106
9202
9401-3
East Yard
9401-2
Poly Tank
Station
2731
9710 3
9204-3
9204-1
SECOND
STREET
9401-2
East Yard
9720 1
9201-1
West Yard
9201-1
9201-2
Building
81-10
Area
THIRD
Waste Z-Oil
Tank
Uranium
Vault
FAST
STREET
Building
Storage
1100
PATROL
ROAD
1000
Filled
Coal Ash
Pond
E 50,000
E 60,000

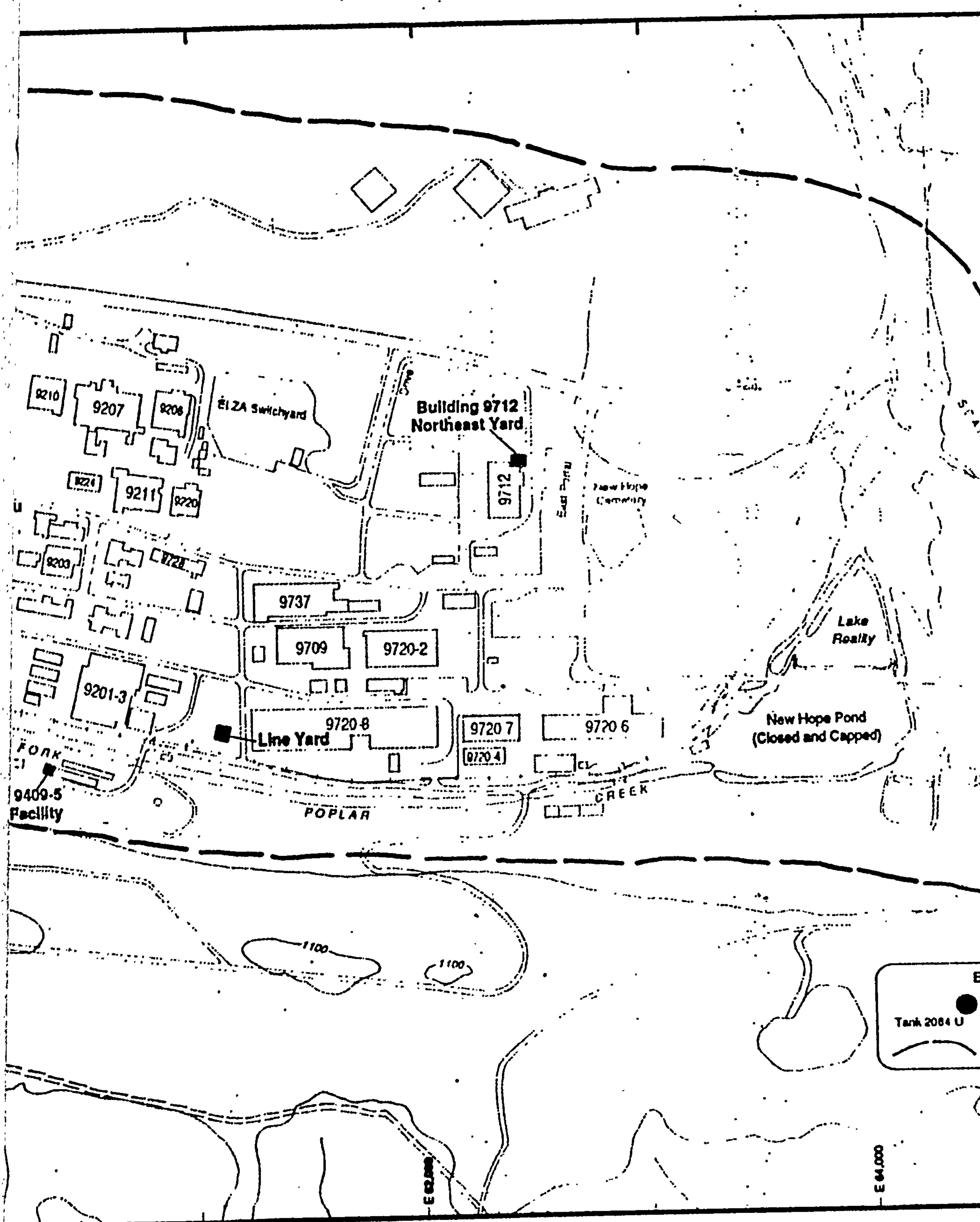


Figure 4-3. Location of RCRA SWMUs in th
Hydrogeologic Regime and o

ne Upper East Fork Poplar Creek
n Chestnut Ridge

Table 4-3. DOE CERCLA Sites at the Y-12 Plant

Site Name	DOE Order 5480.14 CERCLA Program					
	Preliminary Assessment	Phase I	Phase II	Phase III	Phase IV	Phase V
9401-1 Old Steam Plant	X	X	X	—	—	—
9720-2 Drum Storage Area	X	X	X	—	—	—
Old Mercury Storage Area	X	—	—	—	—	—
Bldg 9204-3	X	—	—	—	—	—
Bldg 9404-3	X	X	X	—	—	—
Bldg 9404-6	X	—	—	—	—	—
Bldg 9409-15	X	—	—	—	—	—
Bldg 9418-1	X	—	—	—	—	—
Bldg 9620-2/Z Oil Filter House	X	X	X	—	—	—
Bldg 9731-2	X	—	—	—	—	—
Tank 1067 (East of Bldg 9620-2)	X	X	X	—	—	—
Tank 302 (South of Bldg 9620-2)	X	X	X	—	—	—
Tank 304 (Bldg 9418-4)	X	X	X	—	—	—
Tank 305 (Bldg 9418-5)	X	X	X	—	—	—
Tank 306 (Bldg 9418-6)	X	X	X	—	—	—
Tank 315 (Bldg 9409-3)	X	X	X	—	—	—
Tank B3-304 Bldg 9204-3	X	—	—	—	—	—
Tank B3-338 Bldg 9204-3	X	—	—	—	—	—
Tank B3-339 Bldg 9204-3	X	—	—	—	—	—
Tank Be-305 Bldg 9204-3	X	—	—	—	—	—
Tank X-300 (North of Bldg 9731)	X	—	—	—	—	—
Tank X-301 (North of Bldg 9731)	X	—	—	—	—	—

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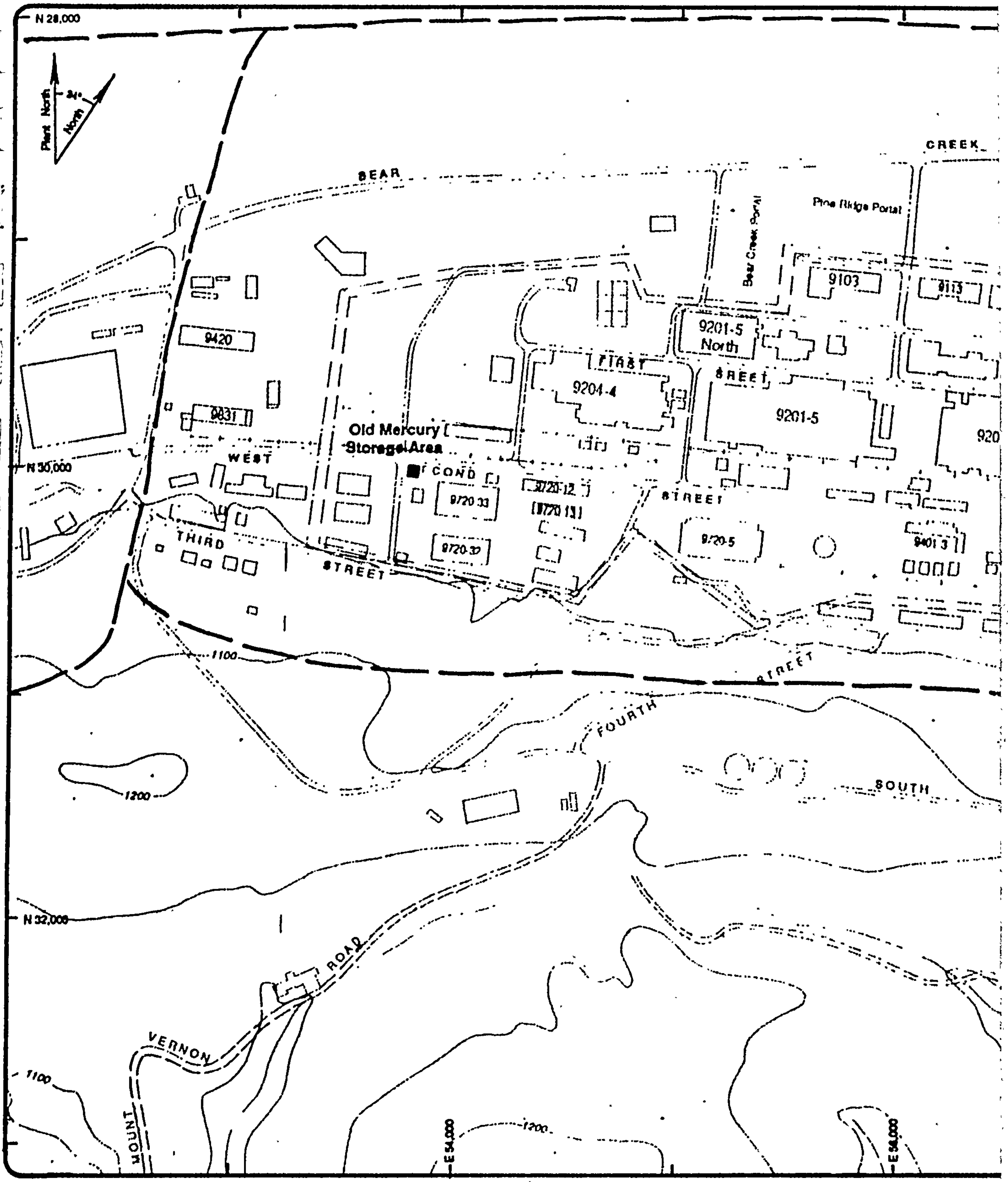
Table compiled from:

1. "Y-12 Plant Environmental Remedial Action Projects", (Map), prepared by KCA Engineering, October 3, 1988, (C2F-XXXXX-SK).
2. "CERCLA Phase II Report, Characterization of Inactive Hazardous Waste Disposal Sites, U.S. DOE Y-12 Plant, Oak Ridge, Tennessee." Prepared by H&R Technical Associates, January 1988 (H&R 260-10)(Draft).

Program Components:

Phase I - Installation Assessment
Phase II - Site Characterization
Phase III - Engineering Assessment
Phase IV - Remedial Action
Phase V - Compliance and Verification

X = Phase Completed



N 28,000
Plant North
North
34°
BEAR
CREEK
Bear Creek Portal
Pine Ridge Portal
9103
9113
9420
9201-5 North
FIRST
STREET
9204-4
9201-5
9831
Old Mercury Storage Area
WEST
COND
N 30,000
9720-12
9720 33
9720-13
STREET
9720-5
9401-3
THIRD
9720-32
STREET
1100
STREET
FOURTH
SOUTH
1200
N 32,000
ROAD
VERNON
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MOUNT
E 54,000
1200
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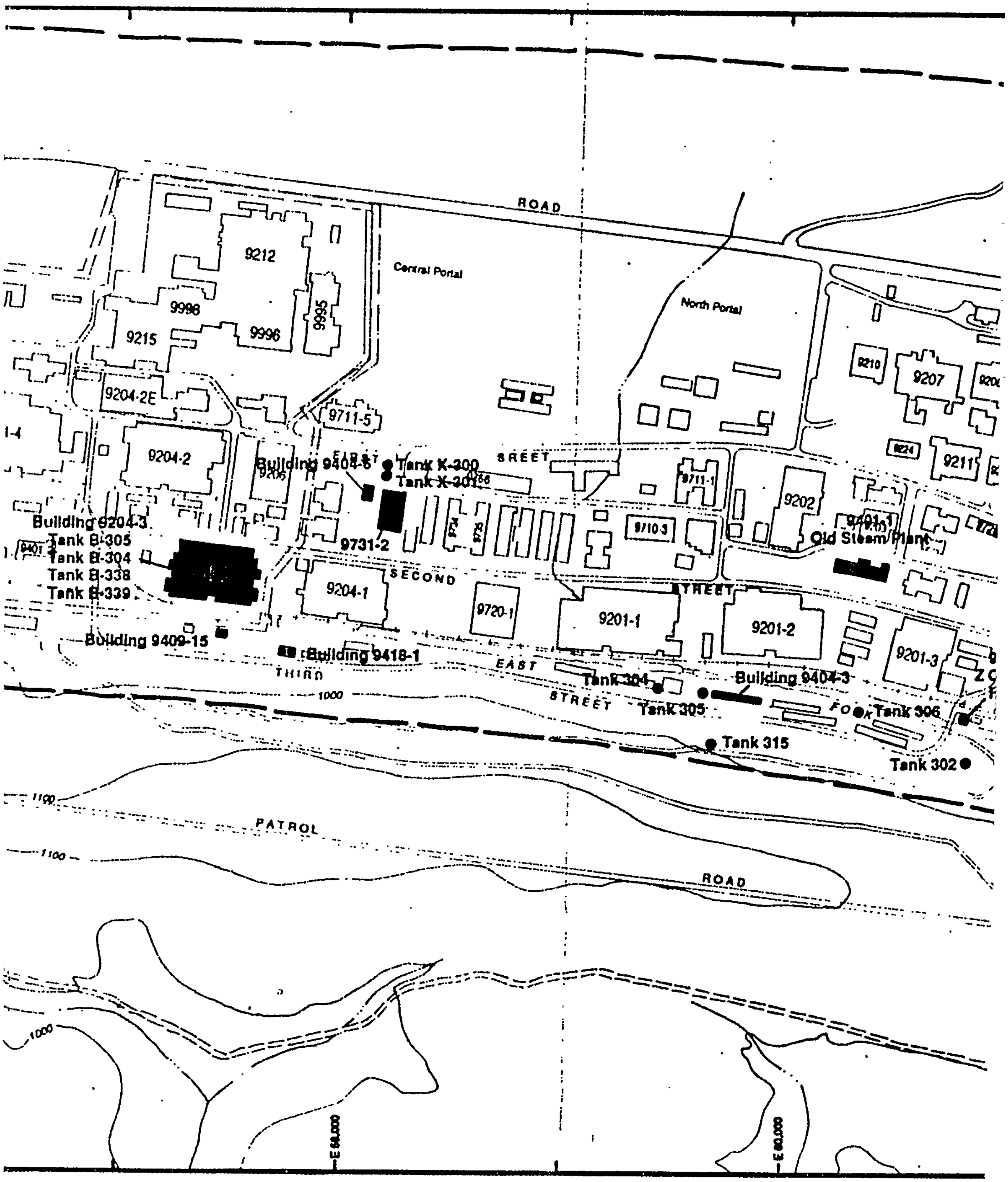
ROAD
Central Portal
North Portal
9212
9998
9996
9995
9215
9204-2E
9711-5
9210
9207
9204-2
9224
9211
FIRST
STREET
Building 9404-6
Tank X-300
Tank X-301
9711-1
9202
9710-3
Building 9204-3
Tank B-305
Tank B-304
Tank B-338
Tank B-339
9731-2
Old Steam Plant
SECOND
STREET
9204-1
9720-1
9201-1
9201-2
9201-3
Building 9409-15
Building 9418-1
THIRD
EAST
STREET
1000
Tank 304
Tank 305
Building 9404-3
Tank 306
Tank 315
Tank 302
1100
PATROL
ROAD
E 58,000
E 60,000

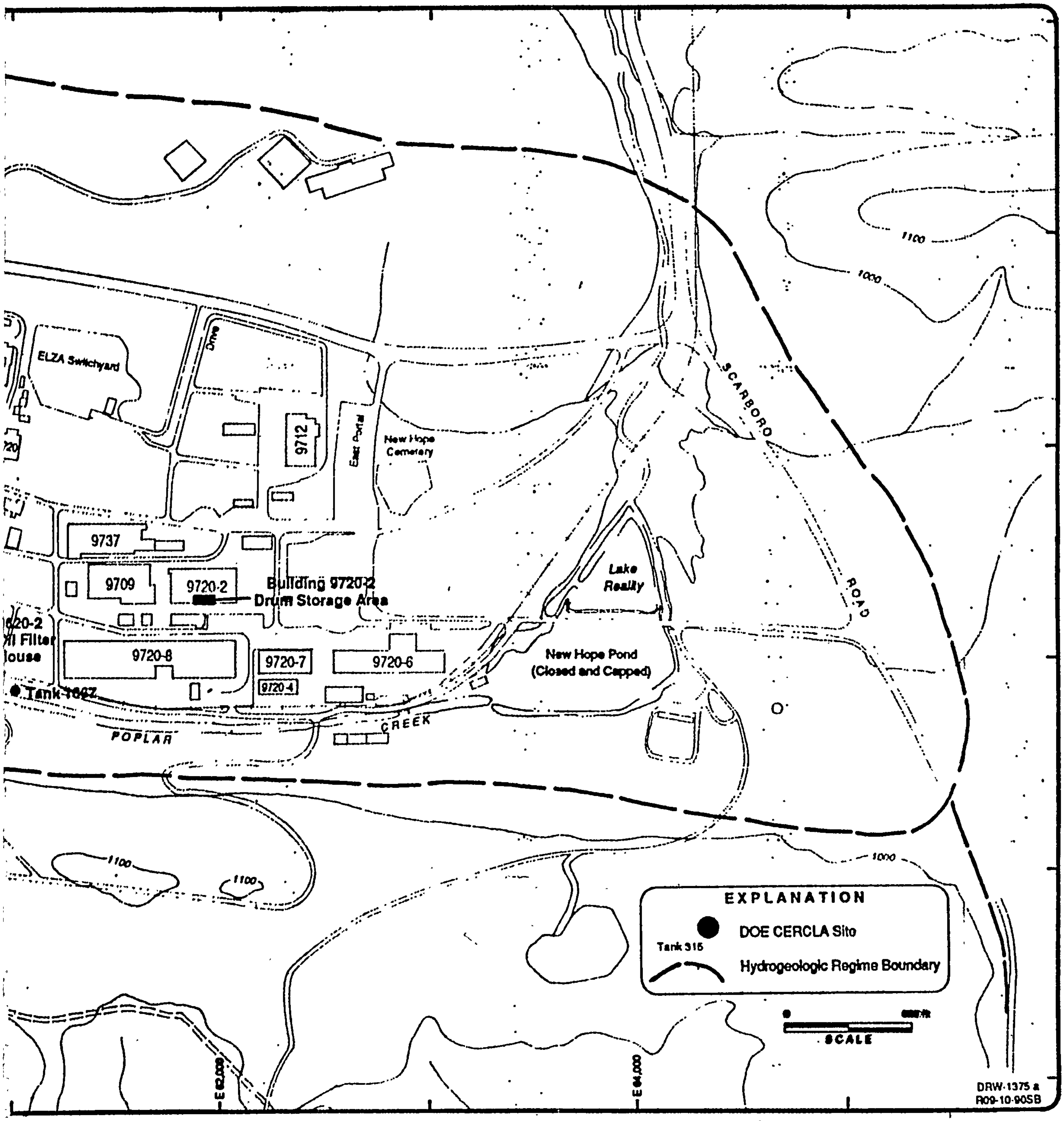

Figure 4-4. Location of DOE CERCLA Sites at theY-12 Plant

sites at the Y-12 Plant may be subject to review under the auspices of the federal CERCLA program. The monitoring programs described herein have been designed in the context of this conservative assumption.

4.1.2 Non-Hazardous Waste Sites

In June 1988, the TDHE issued draft regulations designed to govern all non-hazardous solid waste-management practices in the State of Tennessee (Tennessee Department of Health and Environment, 1988). These regulations will establish six types of non-hazardous solid-waste disposal facilities (SWDF); sanitary municipal landfills (Class I facilities), industrial landfills (Class II facilities), landfills for farming wastes or woody refuse (Class III facilities), landfills for construction, demolition, and other inert wastes (Class IV facilities), land farming facilities (Class V facilities), and surface impoundments used for disposal of non-hazardous wastes (Class VI facilities). Each type of the above listed facilities would be required to have a permit issued by the TDHE except (1) Class III facilities less than 1 acre in size and located at the site of waste-generation, and (2) Class IV facilities less than 1 acre in size.

4.1.3 Underground Storage Tanks

In addition to the provisions regarding SWMUs, HSWA also established under a new Subtitle I to the RCRA regulations, a comprehensive regulatory program for underground storage tanks (USTs). The Subtitle I regulations, contained in 40 CFR Part 280, generally pertain to all USTs used to store "regulated substances". Regulated substances are defined as hazardous substances listed under the CERCLA regulations (40 CFR Part 302) and liquid petroleum products. However, RCRA regulated wastes are specifically exempt from the UST regulations; releases from USTs which contain RCRA wastes are addressed in 40 CFR Parts 264 or 265 Subpart J. A list of the USTs at the

Y-12 Plant subject to regulation under 40 CFR Part 280 is provided on Table 4-4. The locations of these tanks are shown on Figure 4-5.

4.2 STATE AND FEDERAL REGULATIONS

A myriad of state and federal regulations establish the minimum standards and requirements governing all applicable monitoring activities at the Y-12 Plant. The requirements of these regulations range from the very specific, (for which monitoring standards and requirements are specifically mandated in the regulations), to the very broad (for which recommended requirements are contained in regulatory guidance documents). For the purposes of this report, however, specific regulatory citations have been avoided; specific regulatory citations pertaining to ground-water monitoring are summarized in Table 4-5. Because separate sets of regulatory requirements are specified for hazardous waste and non-hazardous waste sites, the requirements for each type of site are discussed separately. In addition, monitoring requirements for USTs, which are not all necessarily waste-management sites, are also discussed separately.

4.2.1 Hazardous-Waste Sites

As discussed in Section 4.0, two general types of hazardous-waste sites are located at the Y-12 Plant; RCRA sites and CERCLA sites. State regulations regarding ground-water monitoring at RCRA regulated hazardous-waste management sites are contained in Chapter 1200-1-11, Rules 1200-1-11-.05 and 1200-1-11-.06 of the TDHE rules for hazardous-waste management, and the corresponding Federal regulations are contained in 40 CFR Parts 265 and 264. As of this writing, no state equivalent to the CERCLA regulations have been promulgated; Federal CERCLA regulations are contained in 40 CFR Part 300.

Table 4-4. Non-SWMU Underground Storage Tanks at the Y-12 Plant

Tank Identification Number	Installation Date	Out of Service Date	Capacity (Gallons)	Contents	Status	Release Detection/ Investigation Results/Schedule	Preliminary Investigation	Release Characterization (Date of EAP or SIP)	Corrective Action
Bear Creek Watershed									
2316-U	1986	In Use	550	Diesel	To be upgraded	12/93	N/A	N/A	N/A
UEFPC Watershed									
0134-U	1966	1982	120	Gasoline	Removed Aug 88	Confirmed Release	Completed	Jan 90	TBD
0439-U	1978	1989	20,000	Gasoline	Removed Sept 89	Confirmed Release	Completed	Oct 89	TBD
0440-U	1978	1989	10,000	Diesel Fuel	Removed Sept 89	Confirmed Release	Completed	See 0434-U	—
0713-U	1955	1988	10,500	No. 2 Fuel Oil	Removed Nov 88	Resample 1990	TBD	TBD	TBD
0928-U	1968	1989	200	Gasoline	Removed May 89	No Release	N/A	N/A	N/A
1219-U	1946	1988	12,000	Diesel Fuel	Removed Dec 89	Confirmed Release	Completed	Dec 87, Aug 88	TBD
1222-U	1968	1988	12,000	Gasoline	Removed Dec 89	No Release	N/A	See 1219-U	—
2068-U	1968	1980	1,000	Gasoline	Removed Feb 90	Sample Feb 90	In Progress	See 1219-U	—
2073-U	1963	1979	1,000	Gasoline	To be removed	TBD	TBD	See 0439-U	—
2074-U	1963	1979	1,000	Gasoline	To be removed	TBD	TBD	See 0439-U	—
2075-U	1963	1979	1,000	Fuel Oil	To be removed	TBD	TBD	See 0439-U	—
2077-U	1953	1964	65	Gasoline	Removed 1964	NI	TBD	TBD	TBD
2078-U	1965	1979	110	Gasoline	Inert Filled 1989	NI	TBD	TBD	TBD
2079-U	1965	1979	55	Gasoline	Inert Filled 1989	NI	TBD	TBD	TBD
2080-U	1971	1987	560	Gasoline	Removed Nov 88	No Release	N/A	N/A	N/A
2081-U	1958	1970	280	Gasoline	To be removed	Sample Apr 90	TBD	TBD	TBD
2082-U	1981	1988	8,000	Gasoline	Removed Dec 89	Confirmed Release	Completed	See 1219-U	—
2099-U	1971	1989	560	Gasoline	Removed Jul 89	No Release	N/A	N/A	N/A
2117-U	1971	1983	550	No. 2 Fuel Oil	Removed Oct 88	Resample 1990	TBD	TBD	TBD
2130-U	1960	In Use	580	Gasoline	To be removed	No Release	N/A	N/A	N/A
2293-U	1954	1975	58	Gasoline	Removed 1975	NI	TBD	TBD	TBD
2294-U	1954	1975	58	Gasoline	Removed 1975	NI	TBD	TBD	TBD
2305-U	1956	In Use	55	Gasoline	To be removed	No Release	N/A	N/A	N/A
2310-U	1964	1989	200	Gasoline	Removed Nov 89	Confirmed Release	Completed	Jan 1990	TBD
2313-U	1986	In Use	550	Diesel	To be upgraded	Dec 1993	N/A	N/A	N/A
2315-U	Not Available	1989	65	Gasoline	Removed Nov 89	Resample 1990	TBD	TBD	TBD
2320-U	1988	In Use	550	Diesel	To be upgraded	Dec 1993	N/A	N/A	N/A
2330-U	1949	1988	5,000	Fuel Oil	Inert Filled 1988	NI	TBD	TBD	TBD
0084-U	1958	1988	500	Used Oil	Removed Jun 88	No Release	N/A	N/A	N/A
0836-U	1945	Not Available	10,000	Used Oil	Removed Oct 89	Confirmed Release	See SWMU S-019	—	—
2102-U	1987	In Use	7,000	Methanol	To be upgraded	Dec 1993	N/A	N/A	N/A
2331-U	1973	1988	560	Gasoline	Removed Dec 88	Confirmed Release	Completed	Dec 1989	TBD
2333-U	1988	In Use	550	Gasoline	To be upgraded	Dec 1993	N/A	N/A	N/A
2338-U	1969	1989	500	Waste Oil	To be removed	May 1990	TBD	TBD	TBD
Chestnut Ridge									
2312-U	1986	In Use	550	Diesel	To be upgraded	Dec 1993	N/A	N/A	N/A

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NI = Not Investigated
N/A = Not Applicable

TBD = To be determined
EAP = Environmental Assessment Plan
SIP = Site Investigation Plan

Table 4-5. Regulatory Requirements for Ground-Water Monitoring Programs at the Y-12 Plant

Regulatory Monitoring Requirements	RCRA Regulated TSD Units					Solid Waste Management Units*	
	Interim Status Sites		Permitted Sites				
	Detection Monitoring	Assessment Monitoring	Detection Monitoring	Compliance Monitoring	Cor. Action Monitoring	RFI Monitoring	CM Monitoring
Monitor Well Network	265.91(a)	265.91(a) 265.90(d)	264.98(b) 264.97(a) 264.97(b) 264.95(a)	264.99(b) 264.97(a) 264.97(b) 264.95(a)	264.100(d) 264.97(a) 264.97(b) 264.95(a)	—	—
Monitor Well Construction Standards	265.91(c)	265.91(c)	264.97(c)	264.97(c)	264.97(c)	—	—
Sampling/Analysis Methods and Procedures	265.92(a)	265.92(a)	264.98(f) 264.97(d) 264.97(e)	264.99(g) 264.97(d) 264.97(e)	264.100(d) 264.97(d) 264.97(e)	264.512(a)	—
Monitored Parameters	265.92(b)	—	264.98(a)	264.99(d) 264.99(f) 264.93	264.100(d) 264.93	—	—
Monitoring Frequency							
Monthly	—	—	—	—	—	—	—
Quarterly	265.92(c)	265.93(d) 265.90(d)	264.98(c)	264.99(d)	264.100(d)	—	—
Semi-Annual	265.92(d)	—	264.98(d)	—	—	—	—
Annual	265.92(d)	—	—	264.99(f)	264.100(d)	—	—
Monitoring Duration	265.90(b)	265.93(d)	264.98(d)	264.99(d) 264.96(a)	264.100(f) 264.96(c)	—	—
Statistical Data Evaluation	265.93(b)	—	264.98(g) 264.97(h)	264.99(h) 264.97(h)	— —	264.511(a)	—
Record Keeping	265.94(a)	265.94(b)	264.73(b)	264.73(b)	264.73(b)	264.513(c)	264.528(b)
Reporting						264.513(a)	264.528(a)
Annual	265.94(a)	265.94(b)	264.77(c)	264.77(c)	264.77(c)	—	—
Semi-Annual	—	—	—	—	264.100(g)	—	—

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— No specific regulatory requirement.
* Preliminary draft only; Draft regulations have not yet been published in Federal Register.

Table 4-5. Continued...

Regulatory Monitoring Requirements	Underground Storage Tanks (UST's)			CERCLA Sites	Non-Hazardous Solid Waste Disposal Facilities (TDHE Regulations)	
	Release Detection	Release Chara.	Corrective Action	Remedial Investigation Monitoring	Detection Monitoring	Assessment Monitoring
Monitor Well Network	280.43(f)	—	—	—	1200-1-7-.04(7)(a)3(i)	1200-1-7-.04(7)(a)3(i)
Monitor Well Construction Standards	280.43(f)	—	—	—	1200-1-7-.04(7)(a)3(ii)	1200-1-7-.04(7)(a)3(ii)
Sampling/Analysis Methods and Procedures	—	—	—	—	1200-1-7-.04(7)(a)4(i)	—
Monitored Parameters	—	—	—	—	1200-1-7-.04(7)(a)4(ii) 1200-1-7-.04(7)(a)6(v)	1200-1-7-.04(7)(a)6(viii)
Monitoring Frequency						
Monthly	280.41(a)	—	—	—	—	—
Quarterly	—	—	—	—	1200-1-7-.04(7)(a)4(iii)	1200-1-70.04(7)(a)6(viii)
Semi-Annual	—	—	—	—	1200-1-7-.04(7)(a)4(iv)	—
Annual	—	—	—	—	1200-1-7-.04(7)(a)4(iv)	—
Monitoring Duration	280.40(c)	—	—	—	1200-1-7-.04(7)(a)5	1200-1-70.04(7)(a)6(vii)
Statistical Data Evaluation	—	—	—	—	1200-1-7-.04(7)(a)6	—
Record Keeping	280.45(b) 280.34(b)	—	—	300.69(a)	1200-1-7-.04(7)(a)5(i)	1200-1-7-.04(7)(a)5(i)
Reporting	280.50(c)	280.65(a)	280.66(c)	300.69(a)	1200-1-7-.04(7)(a)5(ii)	1200-1-70.04(7)(a)6(viii)
Annual	—	—	—	—	—	—
Semi-Annual	—	—	—	—	—	—

5SEP90 Ba

— No specific regulatory requirement.
* Preliminary draft only; Draft regulations have not yet been published in Federal Register.

4.2.1.1 Ground-Water Monitoring at RCRA Sites

The RCRA regulations establish different (but similar) ground-water monitoring requirements for two categories of TSD facilities; interim status facilities, and permitted facilities. The basic monitoring requirements for each category are discussed in the following sections.

4.2.1.1.1 Interim Status Ground-Water Monitoring Programs

Ground-water monitoring during interim status is conducted to ensure that the impact of waste-management activities is monitored and evaluated until closure or a hazardous-waste permit for the site is issued, whereupon the monitoring programs outlined in the permit are implemented. To achieve this goal, the regulations establish a two-stage monitoring program designed to detect (detection monitoring) a contaminant release, and characterize the extent, rate of migration, and concentration distribution of hazardous waste and hazardous-waste constituents released from the site (assessment monitoring).

4.2.1.1.1.1 Detection Monitoring

Detection monitoring is the first phase of the interim status ground-water monitoring program and must be conducted during the active life of the TSD unit (including the post-closure care period for disposal units) until a permit for the site is issued or the facility is clean closed, provided that no ground-water contamination is detected. After receiving a permit, detection monitoring at the site is continued, but must be conducted in accordance with the requirements for permitted facilities, which differ slightly from the interim status detection monitoring requirements.

During the first year of the interim status detection monitoring, background concentrations of all the required constituents are established through quarterly sampling of wells at the site (minimum of one upgradient well and three downgradient wells). At the end of the first year, sampling of all wells is required on a less frequent schedule, the ground-water quality parameters are monitored annually and the contamination indicators are monitored at least semi-annually.

Each time samples are analyzed for the contamination indicators, the results must be statistically compared to their respective background concentrations established during the first year. The regulations stipulate that Cochran's Approximation of the Behrens-Fisher (CABF) Student t-test be used for statistical comparisons. If a statistically significant increase of any of the indicator parameters is determined in wells down-gradient of the site, and subsequently confirmed, then assessment monitoring is initiated as the second phase of the monitoring program.

Interim status detection monitoring at the Y-12 Plant is currently being conducted at three sites; Kerr Hollow Quarry, the East Chestnut Ridge Waste Pile, and the Chestnut Ridge Sediment Disposal Basin (Figure 4-1).

4.2.1.1.1.2 Assessment Monitoring

The goal of interim status assessment monitoring is the determination of the rate and extent of migration, and the concentration of hazardous waste or "hazardous-waste constituents" in ground-water at the site. Hazardous-waste constituents are those constituents listed in Appendix VII to Part 261 of 40 CFR and should not be confused with the more comprehensive list of "hazardous constituents" contained in Appendix IX to Part 264. The distinction between these two lists is important and underscores the purpose of assessment monitoring, which is to provide information to support future decisions regarding the need for and extent of corrective action; characterization of contaminant plumes in terms of Appendix IX constituents is developed through the permitting process.

Assessment monitoring may be triggered from detection monitoring as discussed in the preceding section, or may be initiated from the outset at sites where ground-water contamination is suspected, or known to be present. In either case, assessment monitoring must be conducted quarterly in accordance with a Ground-Water Quality Assessment Plan (GWQAP). The GWQAP must specify the monitor-well network, sampling and analysis procedures, procedures for data evaluation, and a schedule of implementation. Each year, the results of the assessment monitoring program are summarized in a Ground-Water Quality Assessment Report (GWQAR) submitted to the TDHE. The GWQARs for sites associated with the Y-12 Plant are also used as the forum to propose changes and refinements to the assessment monitoring programs at each respective site.

At the Y-12 Plant, assessment monitoring programs are currently in progress at the S-3 Site, Oil Landfarm, Bear Creek Burial Grounds, New Hope Pond, and Chestnut Ridge Security Pits (Table 4-1). Assessment monitoring at the S-3 Ponds, Oil Landfarm, and Bear Creek Burial Grounds was initiated without being triggered from detection monitoring because ground-water contamination at these sites was known to be present. The assessment programs at these sites were initiated in January 1986 although a formalized GWQAP for each site was not submitted to the TDHE until March 1987 (Geraghty & Miller, Inc. 1987a; 1987b; and 1987c). Site-specific annual GWQARs for 1986 through 1988 have been submitted for the S-3 Site, Oil Landfarm, and Bear Creek Burial Grounds. A listing of these reports is provided in the Bibliography (Section 8.0) of this report.

In January 1988, assessment monitoring was initiated at New Hope Pond and the Chestnut Ridge Security Pits and conducted in accordance with GWQAPs submitted to the TDHE in December 1987 and January 1988, respectively (Geraghty & Miller, Inc. 1987d and 1988d). Both of these sites had been undergoing detection monitoring since January 1986. In the second quarter of 1987, however, statistical analyses of the contamination indicator data for each site showed a significant increase in some indicators over their respective background concentrations. Follow-up sampling to confirm the statistical increase was not performed, but data obtained concurrently during characterization monitoring indicated that each site had released contaminants to the ground-water system.

In March 1989, the 1988 annual GWQAR for New Hope Pond and the Chestnut Ridge Security Pits were submitted to the TDHE (Geraghty & Miller, Inc. 1989c and 1989d). These reports contained the first year's assessment monitoring data, as well as an interpretation of the data.

The concepts presented in this ground-water monitoring plan were implemented in 1989 with the submittal of annual Ground-Water Quality Assessment Reports for the Bear Creek Hydrogeologic Regime (Geraghty & Miller, Inc. 1990a and 1990b) and the Upper East Fork Poplar Creek Hydrogeologic Regime (Geraghty & Miller, Inc. 1990c and 1990d). A site-specific GWQAR for 1989 was submitted for the Chestnut Ridge Security Pits (Geraghty & Miller, Inc. 1990e).

4.2.1.1.2 Permit Required Ground-Water Monitoring

By November 1988, new or existing interim status TSD units at the Y-12 Plant were required to have a Part B operating or post-closure permit. Operating TSD units must have permits during the active life of the facility, including the closure period, and interim status units that were closed after January 26, 1983, must have permits during the post-closure care period. Contents of the Part B permit are outlined in 40 CFR Part 270 Subpart B. The Part B permit specifies the applicable ground-water monitoring activities that will be implemented to ensure that any contamination of the uppermost aquifer as a result of a release from the TSD unit is detected, the degree of the release is evaluated, and that corrective action is initiated when such contamination threatens human health or the environment.

To achieve these goals, the regulations establish a three-stage program consisting of detection monitoring, compliance monitoring, and corrective-action monitoring. These programs are graduated such that the level of monitoring effort is progressively increased as the impact of a contaminant release becomes better understood. Thus, detection monitoring is initially implemented. If a contaminant release is detected, and confirmed, compliance monitoring is initiated to monitor the severity of the release, and if pre-determined concentration limits are exceeded, corrective-action monitoring is initiated to determine both the extent of the release and the effectiveness of the corrective actions implemented to mitigate the release. Statistical analysis procedures are the mechanisms which "trigger" the progression from one program to the next.

For interim status sites, ground-water quality conditions at the time of permit application determine which of the three monitoring programs will be implemented. If no contamination has been detected at the site, then the permit application must outline a detection monitoring program. However, if contamination of the uppermost aquifer at the site has been confirmed during interim status, then details regarding either compliance monitoring or corrective-action monitoring must be specified in the permit application; the degree of contamination will determine which of the two programs will be implemented upon permit approval.

4.2.1.1.2.1 Detection Monitoring

For new hazardous-waste TSD units and interim status units where no ground-water contamination has been detected, the site-specific elements of a detection monitoring program meeting the requirements for permitted facilities are specified in the Part B permit. The goal of detection monitoring is to determine whether the site has leaked, or is leaking contaminants into the uppermost aquifer in quantities sufficient to cause a significant change in ground-water quality (U.S. Environmental Protection Agency 1985).

In general, detection monitoring for permitted facilities requires monitoring downgradient of the site for a select set of indicator parameters specified in the permit. The data are statistically compared, using CABF Student t-test or an equivalent statistical procedure, to their respective background values established in background wells over an initial period of one year. If a statistically significant change in the level of any monitored parameter is detected and confirmed, then sampling for Appendix IX constituents must be immediately conducted to enable a complete chemical characterization of the contaminant release. Upon completion of this characterization, monitoring at the site then progresses to compliance monitoring (U.S. Environmental Protection Agency 1985).

Upon approval of their RCRA Part B post-closure permits, detection monitoring will be continued at the Chestnut Ridge Sediment Disposal Basin and the East Chestnut Ridge Waste Pile, provided that no contaminant releases occur before approval of their permit applications. Although Kerr Hollow Quarry is also currently undergoing detection monitoring, this monitoring program will not be continued after closure of the site; Kerr Hollow Quarry is to be clean-closed and will thereby be exempt from post closure ground-water monitoring.

4.2.1.1.2.2 Compliance Monitoring

The goal of compliance monitoring is to determine whether leakage of Appendix IX constituents into the uppermost aquifer has exceeded acceptable levels specified in the Part B permit as part of the Ground-Water Protection Standard (GWPS). The GWPS is one of the most important aspects of the hazardous-waste permit. It not only provides the framework for compliance monitoring, but also defines the action levels and clean-up standards for corrective-action. A GWPS consists of four elements:

(1) A list of all the Appendix IX constituents present in ground water at the site;

(2) The maximum allowable concentration of each constituent defined by either the background level of the constituent, the maximum contamination level (MCL) established by the EPA (if available), or an alternate concentration limit (ACL) that has been demonstrated to not pose a substantial present or potential threat to human health or the environment;

(3) The location where the GWPS is applied (the point of compliance) and hence where compliance monitoring is conducted; and

(4) The period during which the GWPS applies (the compliance period) which is equal to the active life of the facility including the closure period (U.S. Environmental Protection Agency 1985).

For permitted TSD units, the GWPS is established through a permit modification after a contaminant release has been detected and confirmed, and Appendix IX sampling to initially characterize the release has been completed. For interim status facilities, however, the GWPS is established in the initial permit application, not through a subsequent permit modification. Part B permit applications for interim status sites which have released contaminants to the uppermost aquifer must contain a characterization of any existing plume of contamination which identifies the maximum concentrations of all the Appendix IX constituents within the plume. The GWPS is therefore based upon the Appendix IX plume-characterization data collected prior to permitting.

Compliance monitoring is essentially a program of routine monitoring conducted to ensure that the facility is in compliance with its GWPS. During compliance monitoring, all wells at the point of compliance are sampled quarterly and analyzed for all of the constituents included in the site GWPS. In addition, all compliance point wells must be sampled at least annually and analyzed for the Appendix IX constituents to determine if additional hazardous constituents have been released from the site.

After each quarterly monitoring event, the data must be statistically analyzed in accordance with an approved statistical procedure. If statistical analyses of the data indicate that the concentration limits specified in the GWPS have been statistically exceeded in any well at the point of compliance, a corrective-action program must be initiated to bring the facility back into compliance with its GWPS (U.S. Environmental Protection Agency, 1985).

At this time there are no permitted RCRA TSD units at the Y-12 Plant for which compliance monitoring is applicable; therefore, the only sites at the Y-12 Plant for which compliance monitoring may be applied upon permit issuance are the eight interim status RCRA TSD units. As shown on Table 4-1, the need for compliance monitoring at the S-3 Site WMA, the Oil Landfarm WMA, the Bear Creek Burial Grounds WMA, New Hope Pond, and the Chestnut Ridge Security Pits has yet to be determined because the concentration limits for the hazardous constituents included in each sites GWPS have not been established. Once they are established, however, it is not likely that any of these sites will undergo compliance monitoring because the maximum concentrations of many of the constituents included in each GWPS currently exceed either background levels, MCLs, or both, and are likely to exceed any ACL that may be granted by the TDHE.

4.2.1.1.2.3 Corrective-Action Monitoring

Under RCRA, ground-water monitoring must be conducted in conjunction with corrective action to demonstrate the effectiveness of the remedial measures. However, the regulations governing corrective-action monitoring are far less detailed than those concerning either detection or compliance monitoring.

Although very generalized, the corrective-action regulations give some indications as to minimum corrective-action monitoring requirements. For one, the regulations state that corrective-action monitoring may be based on compliance monitoring. In addition, because the RCRA regulations require corrective action to address contaminated ground water located between the point of compliance and the downgradient property boundary, periodic sampling of additional wells not located at the point of compliance may also be required. However, it would not likely be necessary to analyze samples from these wells for the complete suite of Appendix IX constituents; only those hazardous constituents which triggered corrective action (i.e. exceeded their respective concentration limits specified in the sites GWPS) would warrant monitoring.

4.2.1.2 Ground-Water Monitoring at SWMUs

In response to HSWA, the EPA developed technical guidance regarding contamination investigations at SWMUs subject to regulation under RCRA section 3004(u). Interim final guidance documents were issued in May 1989 which outline a three-phase program consisting of a RCRA Facility Assessment (RFA), a RCRA Facility Investigation (RFI), and the selection and implementation of Corrective Measures (CM) (U.S. Environmental Protection Agency 1989). Although ground-water monitoring may be required in some instances, a RFA usually involves a "desk top" review of existing information to identify all SWMUs at the facility and those SWMUs needing further investigation under an RFI. The RFA documents prepared by Energy Systems (Welch, et al. 1987; Welch 1987; Wiggins and Welch 1988a, 1988b; Murphy 1989) identified the SWMUs at the Y-12 Plant for which RFIs are planned (Table 4-2).

Ground-water monitoring is required at a SWMU if, based on the results of the RFA, it is determined that contaminants have been, or are suspected to have been released to the ground-water system underlying the SWMU. Specific details regarding the monitoring program, including monitored parameters, monitoring frequency and duration, and the monitor-well network, must be specified in an RFI work plan submitted to appropriate regulatory agency for approval.

Guidance documents prepared by the EPA indicate that an initial monitoring phase will be required to determine if a contaminant release has occurred. Further ground-water investigation may be terminated if the results indicate that a release to the ground-water system has not occurred. However, if a release has occurred, then subsequent monitoring phases will be required to determine the chemical composition and the areal and vertical extent of the contaminant release, as well as the rate of contaminant migration (U.S. Environmental Protection Agency 1986). It is important to note that, unlike contamination assessment programs for RCRA TSD units, monitoring at SWMUs may be terminated once the contaminant plume has been adequately characterized.

4.2.1.3 Ground-Water Monitoring at CERCLA Sites

The RCRA regulations outline in detail the requirements for specific ground-water monitoring programs, whereas the CERCLA regulations include ground-water monitoring as one of several aspects of a broadly scoped Remedial Investigation/Feasibility Study (RI/FS). The RI/FS process represents a two-pronged approach to contamination assessments at CERCLA sites. The remedial investigation is the data collection mechanism for the feasibility study effort. Accordingly, the remedial investigation emphasizes data collection and site-characterization (monitoring).

Like the RFI process for SWMUs, the specific requirements for ground-water monitoring during a CERCLA remedial investigation are not explicitly defined in the regulations, but are recommended in guidance documents prepared by the EPA. Thus, specific details regarding monitored parameters, monitoring frequency and duration, and the monitor-well network are developed on a site-by-site basis, and are contained in a work plan submitted to appropriate regulatory agency for approval before the remedial investigation is initiated. When a sufficient amount of data has been generated to support the feasibility study, ground-water monitoring efforts are terminated.

4.2.2 Non-Hazardous Solid Waste Disposal Facilities

Under the TDHE solid waste regulations, ground-water monitoring is required at all new and existing Class I, II, and III solid-waste disposal facilities (SWDFs) (see

Section 4.1.2). Monitoring at Class IV SWDFs is not required unless specifically requested by the TDHE and ground-water monitoring requirements for Class V and VI SWDFs are not currently specified in the regulations. The level of monitoring effort is dependent upon the type of facility with the most stringent monitoring required at Class I SWDFs and the least stringent at Class III sites.

The solid waste regulations, like the regulations governing RCRA regulated TSD facilities, specifically outline minimum standards for ground-water monitoring. These standards require each SWDF to have a minimum of three monitor wells (one upgradient, and two downgradient) and a detailed ground-water sampling and analysis plan. In addition, the solid waste regulations also share the GWPS and compliance boundary concepts with the RCRA regulations. As with RCRA TSD facilities, conformance with the GWPS is determined at the compliance boundary.

Like the RCRA monitoring programs, monitoring requirements under the solid-waste regulations have been structured such that the level of monitoring effort is progressively increased if a contaminant release is suspected. Thus, detection monitoring is initially required to determine if the site has leaked or is leaking contaminants of the ground-water system. If so, assessment monitoring is implemented to characterize the extent of the release.

4.2.3 Underground Storage Tanks

Like the regulations governing SWMUs and CERCLA sites, few specific requirements for ground-water monitoring have been established for USTs. In general, the UST regulations require ground-water monitoring in only two instances; (1) as one of several acceptable leak detection alternatives, and (2) during site characterization to determine the extent of a release of regulated substances from the UST.

4.2.3.1 Release Detection Monitoring

Release or leak detection forms a major component of the UST regulations. Owners and operators of all UST systems must comply with release detection requirements within the time frames shown on Table 4-6. The regulations outline several alternative methods for release detection, including inventory control, manual tank gauging, tank tightness testing, automatic tank gauging, vapor monitoring, ground-water monitoring, interstitial monitoring, or an alternative method approved by the appropriate regulatory agency. Regardless of the type of method or combinations of methods employed, however, release detection must be performed at least once every 30 days, unless the UST system complies with several performance standards and monthly inventory control requirements.

If ground-water monitoring is selected as the method of release detection, the following minimum standards are required:

(1) Ground water must not be more than 20 feet below grade and the hydraulic conductivity of the soils between the UST system and the monitor wells can not be less than 0.01 centimeters per second;

(2) Monitor wells must be located to intercept the excavated zone around the UST or are as close to it as technically feasible, and must be clearly marked and secured to avoid unauthorized access and tampering;

(3) Monitor wells must be screened to allow entry of the regulated substance into the well under both high and low water-table conditions, and the screened portion of the well must be designed to prevent migration of soil or filter-pack materials into the well;

(4) Monitor wells must be sealed from the ground surface to the top of the filter pack; and

(5) Design of the monitor wells must accommodate the detection of at least one-eighth of an inch of free product.

To ensure compliance with the above listed standards and to establish the number and positioning of wells, the UST regulations require a preliminary site assessment of the area

Table 4-6. Schedule for Phase-In of Release Detection Requirements for Underground Storage Tanks

Year System was Installed	Year When Release Detection is Required				
	1989	1990	1991	1992	1993
Unknown or before 1965	RD	P	—	—	—
1965 - 1969	—	P/RD	—	—	—
1970 - 1974	—	P	RD	—	—
1975 - 1979	—	P	—	RD	—
1980 - 1988	—	P	—	—	RD
1989 (New Tanks)	Immediately upon installation.				

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P = Must inititate release detection for all pressurized piping.
RD = Must initiate release detection for tanks and suction piping.

FROM: "40 CFR Part 280; Final Rule, Technical Standards and Corrective Action Requirements for Owners and Operators of Undergound Storage Tanks", U.S. Environmental Protection Agency Office of Underground Storage Tanks.

within and immediately below the UST system. The regulations further require the owner/operator to maintain records for at least one year of the results for sampling, testing, or monitoring.

4.2.3.2 Site Characterization Monitoring

Upon confirmation of a release at a UST, an initial site characterization is required to obtain information regarding the nature of the release. Based upon this initial information, a complete characterization of the release is required if any of the following conditions are observed;

(1) There is evidence that ground water (supply) wells have been affected by the release;

(2) Recoverable free product is present;

(3) There is evidence that contaminated soils may be in contact with ground water; or

(4) The TDHE requests a full characterization of the release.

Specific details regarding the monitoring activities that will be implemented to determine the extent of the release must be submitted to the TDHE in an Environmental Assessment Plan (EAP). An EAP may be considered analogous to a GWQAP prepared for interim status TSD units, and like a GWQAP, the EAP must specify the number and location of wells, monitored parameters, and monitoring frequency that will be implemented to determine the extent of the release. Results of the EAP must be summarized in an Environmental Assessment Report (EAR).

Upon review of the EAR, the TDHE may require corrective action to remove dissolved product from the ground water. However, it is important to note that corrective action may be requested by the TDHE at any time during the site characterization. Further ground-water monitoring may therefore be requested by the TDHE as a means of evaluating the effectiveness of the corrective action.

4.3 DOE ORDERS FOR GROUND-WATER MONITORING

In October 1988, the DOE issued Order 5400.1 directed towards establishing requirements and guidance for radiological effluent monitoring and environmental surveillance conducted in support of DOE operations and activities. This order established as DOE policy that environmental surveillance programs be conducted to (1) determine whether the public and the environment are adequately protected during DOE operations and whether operations are in compliance with DOE and other applicable Federal, State, and local radiation standards and requirements, (2) be capable of detecting and quantifying unplanned releases, and (3) that they meet the high standards of quality and creditability.

The environmental surveillance program outlined in DOE Order 5400.1 requires monitoring of terrestrial and aquatic foodstuffs, soil and sediment, surface water, and ground water. With respect to ground water, DOE Order 5400.1 requires that "ground waters that may potentially be affected by DOE operations be monitored to determine and document the effects of such operations on ground-water quality and quantity and to demonstrate compliance with applicable Federal and State laws and regulations" (U.S. Department of Energy 1988).

Although DOE Order 5400.1 is specifically directed towards radiological monitoring, monitoring for hazardous wastes and hazardous waste constituents is also required. It is further recommended that ground-water monitoring at DOE facilities be conducted on-site and in the vicinity of DOE facilities to:

(1) Obtain data for the purpose of determining base-line conditions of ground-water quality and quantity;

(2) Demonstrate compliance with and implementation of all applicable regulations and DOE orders;

(3) Provide data for early detection of ground-water pollution or contamination;

(4) Identify existing and potential ground-water contamination sources and to maintain surveillance of these sources; and

(5) Provide data upon which decisions can be made concerning land disposal practices and the management of ground-water resources.

In addition to the above listed general requirements, DOE Order 5400.1 also contains recommendations regarding monitor-well construction and location, ground-water sampling frequency, sampling and analytical methods, sample sizes, and methods of sample preservation. These quality-assurance issues are discussed in more detail in Section 6.0 of this report.

4.4 APPROACH FOR REGULATORY COMPLIANCE

A review of the preceding discussion of regulatory programs illustrates that the RCRA and non-hazardous SWDF regulations are very similar in their approach to ground-water monitoring and that these two regulatory programs provide far more detailed monitoring requirements than any of the regulations governing SWMUs, CERCLA sites, and USTs. Due to these similarities, the RCRA monitoring programs will be used as the framework for regulatory compliance at the Y-12 Plant. Thus, four basic monitoring programs will be conducted: detection, assessment, compliance, and corrective action monitoring.

The relationship of the monitoring programs to the various waste sites at the Y-12 Plant is illustrated on Figure 4-6. As shown, detection monitoring will be conducted only at RCRA regulated TSD units and SWDFs, where appropriate based upon ground-water quality conditions and the permit status of each site. Assessment monitoring, a RCRA interim status program and a monitoring program for SWDFs, will be expanded in scope to accomplish the objectives of monitoring at SWMUs, USTs, CERCLA sites, and to comply with DOE orders. In its expanded form, assessment monitoring will be the principal mechanism for the collection of monitoring data at all leaking waste sites associated with

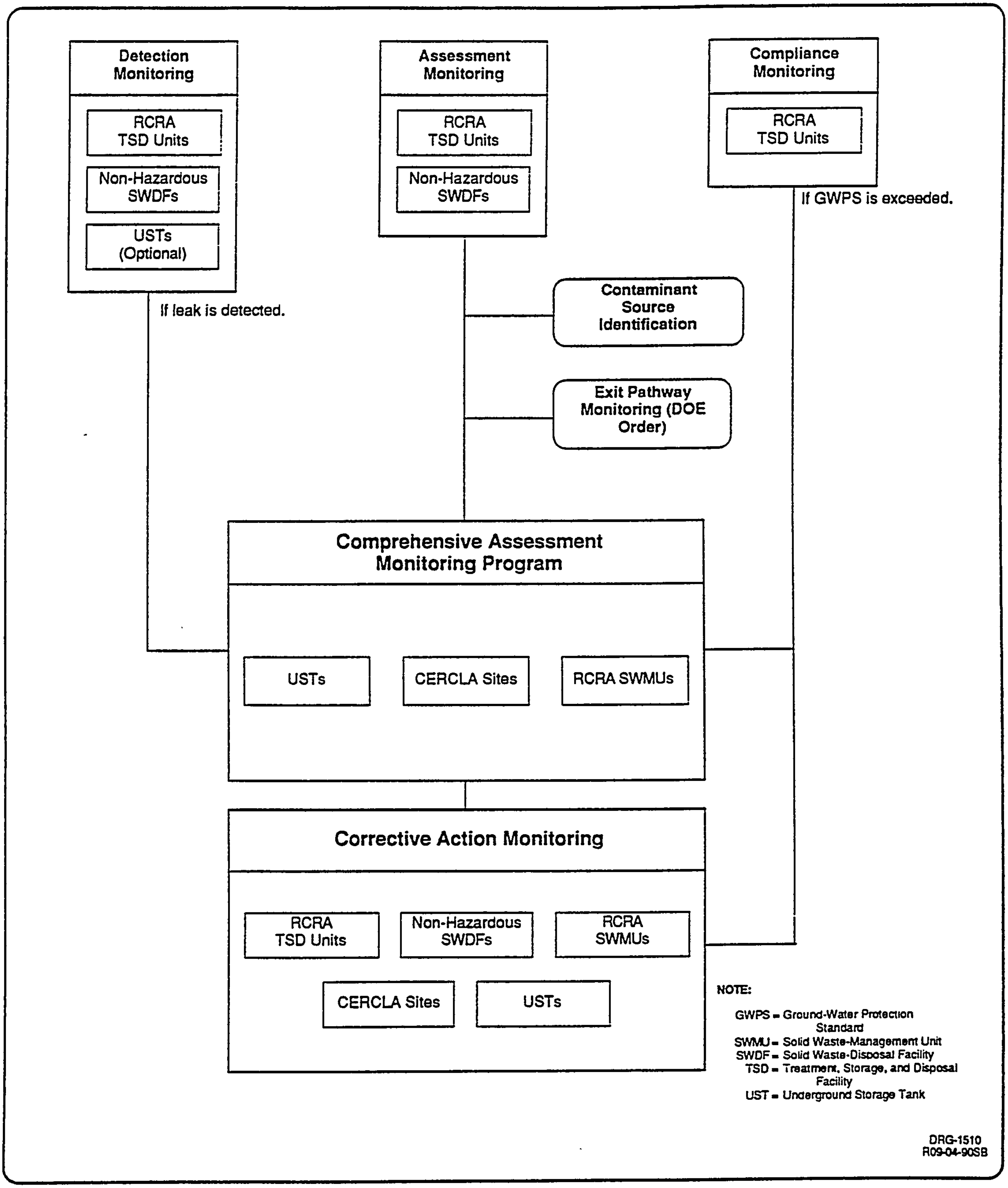

Figure 4-6. Overview of Ground-Water Monitoring Programs at the Y-12 Plant

the Y-12 Plant. Compliance monitoring will only take place at RCRA regulated units. Corrective action monitoring will be conducted during the design and implementation of corrective actions and will essentially be an evolved form of assessment monitoring.

4.4.1 Detection Monitoring

Detailed requirements for detection monitoring are outlined only for RCRA TSD units and SWDFs; although the monitoring requirements for each differ slightly, the fundamental objectives are the same. Detection monitoring at RCRA regulated units has been effectively managed in the past through implementation of the Y-12 Plant "Base Program". Developed by Energy Systems in 1986, the Base Program essentially represents a standardized suite of monitored parameters based upon RCRA requirements. This program has proven effective in maintaining a consistent technical approach to ground-water sampling activities at all hazardous and non-hazardous waste sites at the Y-12 Plant for which detection monitoring is appropriate. A comparison of the Base Program with RCRA and SWDF monitoring requirements is shown in Table 4-7. As shown, the suite of monitored parameters included in the first year of the Base Program incorporates total uranium and omits herbicides and pesticides not utilized at the Y-12 Plant and not detected in ground water at the Plant. These omissions from the Base Program have been approved by the TDHE. In addition, the Base Program includes a suite of VOCs (Table 4-8).

The suite of monitored parameters included in the first year of the Base Program are similar to those listed for SWDFs. Parameters required for SWDFs which were not included in the Base Program include COD, TDS, ammonia, and cyanide. In addition, annual monitoring for a more complete list of VOCs is required for SWDFs (Table 4-8). DOE should be able to resolve these differences through negotiations with the TDHE.

Table 4-7. Regulatory and Base Program Requirements for Detection Monitoring

Parameters and Constituents	Quarterly Monitoring (first year only)			Semi-Annual Monitoring			Annual Monitoring		
	RCRA Interim Status Sites	Base Program	Solid-Waste Disposal Facilities	RCRA Interim Status Sites	Base Program	Solid-Waste Disposal Facilities	RCRA Interim Status Sites	Base Program	Solid-Waste Disposal Facilities
Ground-Water Quality									
Chloride	X	X	X	—	—	X	X	X	—
Iron	X	X	X	—	—	X	X	X	—
Manganese	X	X	X	—	—	X	X	X	—
Sodium	X	X	X	—	—	X	X	X	—
Sulfate	X	X	X	—	—	X	X	X	—
Phenols	X	X	—	—	—	—	X	X	—
Contamination Indicators									
Chemical Oxygen Demand (COD	—	—	X	—	—	X	—	—	—
Total Dissolved Solids (TDS)	—	—	X	—	—	X	—	—	—
Total Organic Carbon (TOC)	X	X	X	X	X	X	—	—	—
Total Organic Halogen (TOX)	Optional	X	—	Optional	X	—	—	—	—
Specific Conductance	X	X	—	X	X	—	—	—	—
pH	X	X	X	X	X	X	—	—	—
Site Specific Waste Constituents	Optional	—	—	Optional	—	—	—	—	—
Drinking-Water Quality									
Arsenic	X	X	X	—	—	—	—	—	—
Barium	X	X	X	—	—	—	—	—	—
Coliform Bacteria	X	X	—	—	—	—	—	—	—
Cadmium	X	X	X	—	—	—	—	—	—
Chromium	X	X	X	—	—	—	—	—	—
Fluoride	X	X	—	—	—	—	—	—	—
Lead	X	X	X	—	—	—	—	—	—
Mercury	X	X	X	—	—	—	—	—	—
Nitrate (as N)	X	X	X	—	—	X	—	—	—
Selenium	X	X	X	—	—	—	—	—	—
Silver	X	X	X	—	—	—	—	—	—
Volatile Organic Compounds	—	Optional	—	—	Optional	—	—	Optional	X
Herbicides/Pesticides									
Endrin	X	—	—	—	—	—	—	—	—
Methoxychlor	X	—	—	—	—	—	—	—	—
2,4-D	X	—	—	—	—	—	—	—	—
Lindane	X	—	—	—	—	—	—	—	—
Toxaphene	X	—	—	—	—	—	—	—	—
2,4,5-TP Silvex	X	—	—	—	—	—	—	—	—
Radiological Parameters									
Radium	X	X	—	—	—	—	—	—	—
Gross Alpha	X	X	—	—	—	—	—	—	—
Gross Beta	X	X	—	—	—	—	—	—	—
Others									
Ammonia (as N)	—	—	X	—	—	X	—	—	—
Calcium	—	X	X	—	—	X	—	—	—
Cyanide	—	—	X	—	—	—	—	—	—
Magnesium	—	X	X	—	—	X	—	—	—
Potassium	—	X	X	—	—	X	—	—	—
Total Uranium	—	X	—	—	—	—	—	X	—

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Table 4-8. Volatile Organic Compounds Included in the Base Program and Additional VOCs Required for New Solid Waste-Disposal Facilities

Base Program Parameters	
Acetone	1,2-Dichloroethene (total)
Bromodichloromethane	1,2-Dichloropropane
Benzene	cis-1,3-Dichloropropene
Bromoform	trans-1,3-Dichloropropene
Bromomethane	Ethylbenzene
2-Butanone	2-Hexanone
Carbon disulfide	Methylene chloride
Carbon tetrachloride	Styrene
Chlorobenzene	1,1,2,2-Tetrachloroethane
Chlorodibromomethane	Tetrachloroethene
Chloroethane	Toluene
Chloroform	1,1,1-Trichloroethane
Chloromethane	1,1,2-Trichloroethane
1,1-Dichloroethane	Trichloroethene
1,2-Dichloroethane	Vinyl Chloride
1,1-Dichloroethene	Xylenes (total)
Additional Parameters Required for Solid-Waste Disposal Facilities	
Acrolein	Dichlorodifluoromethane
Acrylonitrite	Ethanol
Bromochloromethane	Ethyl mechacrylate
4-Bromofluorobenzene	Iodomethane
2-Chloroethyl vinyl ether	Trichlorofluoromethane
Dibromomethane	1,2,3-Trichloropropane
1,4-Dichloro-2-butane	

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4.4.2 Assessment Monitoring

Assessment monitoring is presently being implemented at five RCRA regulated TSD units at the Y-12 Plant and has been proven effective. This program will be expanded to satisfy monitoring objectives at SWMUs, USTs, and CERCLA sites and comply with DOE orders. Expansion of the program will facilitate monitoring of clusters of sites where dictated by overlapping plumes and the mechanics of the flow system. Surface water monitoring stations, including springs, will be identified for each site or cluster of sites to determine the effect of contamination that may be discharged from the ground-water system. Exit pathways will also be monitored to comply with DOE orders. This will focus on the Maynardville Limestone which acts as the primary hydrogeologic drain for Bear Creek Valley, UEFPC, and portions of Chestnut Ridge.

The source identification component will be implemented at SWMU and CERCLA sites where soil sampling has indicated releases have occurred. If a release cannot be attributed to the site, it will no longer be subject to monitoring. Annual reports presenting analytical data and interpretations will be submitted for each hydrogeologic regime. The importance of the role played by assessment monitoring in the characterization of ground water and surface water data from the Y-12 Plant is paramount. The technical approach for the actual implementation of the program is presented in Section 5.0.

4.4.3 Compliance Monitoring

Compliance monitoring is applicable only to permitted RCRA TSD units; there is no equivalent monitoring program currently defined under the state or Federal regulations governing ground-water monitoring at SWMUs, CERCLA sites, USTs, or non-hazardous SWDFs. Moreover, the RCRA regulations governing compliance monitoring explicitly outline minimum performance standards. Thus, the site-specific details for compliance monitoring fulfilling all regulatory requirements will be provided in the Part B operating or post-closure permits for those sites for which this program is applicable (see Section 4.2.1.1.2). Applicable RCRA sites include those "triggered" into compliance monitoring from detection monitoring, and those sites which "return" to compliance monitoring from corrective action monitoring.

4.4.4 Corrective Action Monitoring

As noted previously, corrective-action monitoring is mandated only by the regulations governing permitted RCRA TSD units which, aside from providing the data needed to evaluate the effectiveness of the corrective action efforts, define no other specific performance standards. This lack of specific regulatory requirements, however, imparts a significant degree of flexibility to the technical approach for corrective-action monitoring. Furthermore, the absence of detailed regulatory controls facilitates development of a comprehensive corrective-action monitoring program capable of evaluating the overall effectiveness of concerted site-specific corrective actions throughout each hydrogeologic regime at the Y-12 Plant.

Corrective action monitoring will likely incorporate aspects of compliance monitoring and assessment monitoring, including monitoring at the point of compliance for RCRA sites, an integrated monitor-well network between sites (based upon existing assessment well network), a standardized suite of monitored parameters and constituents, and a quarterly sampling frequency. Annual reports summarizing the results of the corrective-action monitoring program will also be needed to comply with RCRA regulations.

5.0 TECHNICAL APPROACH TO ASSESSMENT MONITORING

The following sections outline the technical approach for implementation of the assessment monitoring program for the Y-12 Plant hydrogeologic regimes. As discussed in Section 2.0, the Y-12 Plant has been subdivided into three hydrogeologic regimes, (Bear Creek, UEFPC, and Chestnut Ridge) defined on the basis of the geology and the surface and ground-water flow systems. The assessment program in each regime consists of four basic components; (1) contaminant-source identification, (2) contaminant plume definition, (3) exit pathway monitoring, and (4) recordkeeping and reporting. Each component has been tailored to the individual characteristics of each regime, such as hydrogeology and the number of potential contaminant source areas. Thus, some components receive more emphasis (e.g contaminant-source identification in the UEFPC hydrogeologic regime) in one regime than in another. This approach allows the assessment program to be focused where concerted efforts are needed.

5.1 BEAR CREEK HYDROGEOLOGIC REGIME

The following sections outline a proposed technical approach for surface water and ground-water monitoring in the Bear Creek hydrogeologic regime. To the extent possible, recommendations for additional monitoring efforts were kept to a minimum and much of the proposed monitoring represents the re-direction of current monitoring activities to exit pathway monitoring and to complete the delineation of contaminant plumes.

5.1.1 Contaminant Source Identification

With the exception of the SY-200 Yard SWMU (Figure 4-2), all the potential sources of ground-water contamination in the Bear Creek hydrogeologic regime are presently being investigated, and efforts to determine the extent of contamination from these sources are near completion. In order to determine if contaminants have been released from the SY-200 Yard, a preliminary investigation will be conducted. This investigation involves soil sampling and analysis for a suite of contamination indicator parameters and parameters determined from previous investigations and the items known to or suspected to have been handled at the site; specific details of this investigation will be presented in the RFI Plan for the SY-200 Yard.

If the results of the soils analyses indicate that contaminants have been released from the SY-200 Yard, then the installation of temporary piezometers at locations upgradient and downgradient of the site is recommended. Ground-water samples from the temporary piezometers would be analyzed for the contaminants detected in the soil samples to determine if they have also entered the ground-water system.

Water-quality data from the upgradient piezometers will be used to determine if contaminants present in ground water may be directly attributed to releases from sites upgradient of the SY-200 Yard (S-3 Site, or Spoil Area I). If this is determined to be the case, further evaluation of ground-water contamination at the SY-200 Yard will then be terminated. However, should the water-quality data from piezometers located downgradient of the site indicate that the SY-200 Yard has released contaminants to the ground-water system, locations for the installation of permanent RCRA quality monitor wells will be evaluated. Further investigation of ground-water contamination at the SY-200 Yard would then be incorporated into the overall assessment program for the Bear Creek hydrogeologic regime described in the following section.

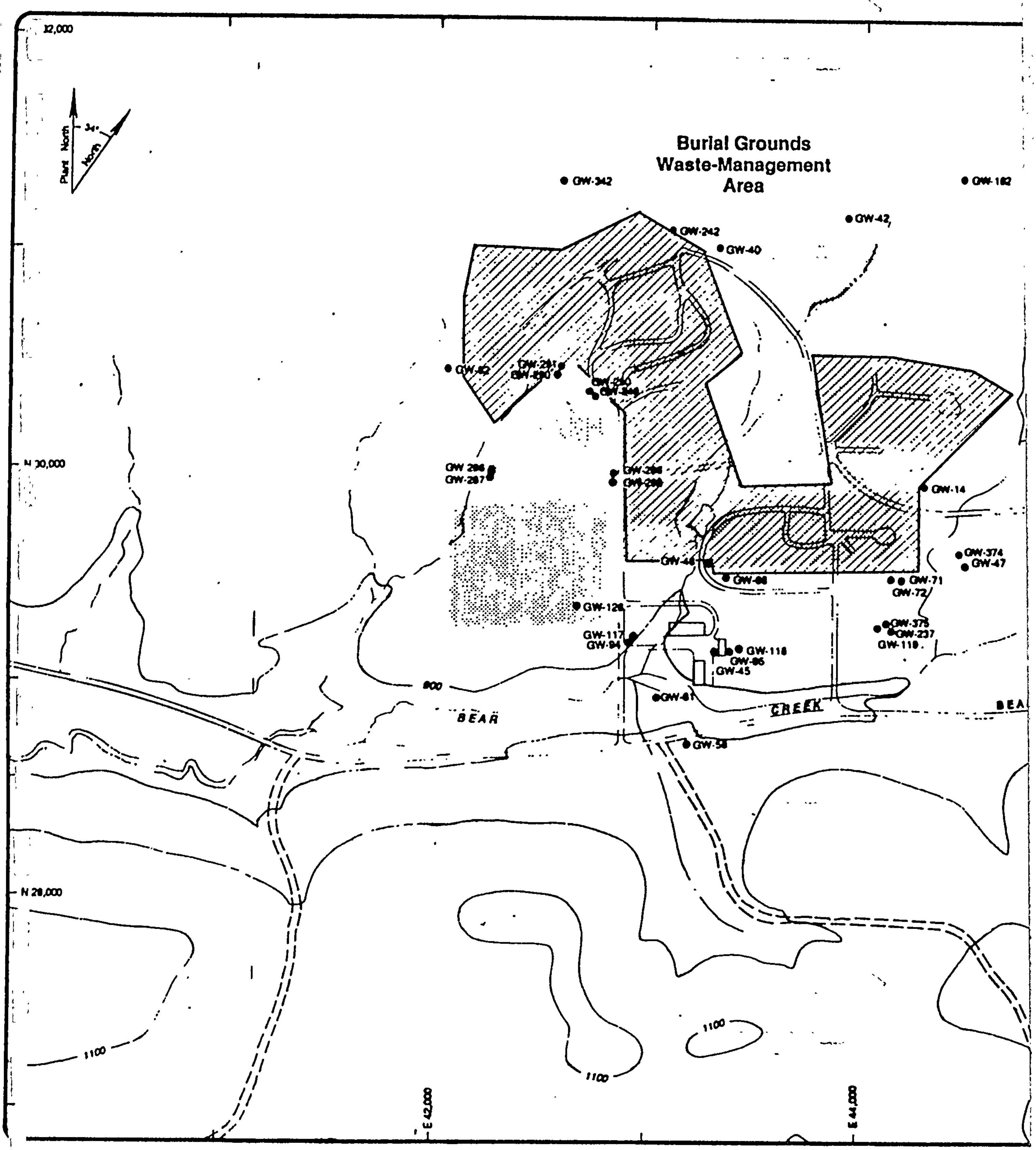
5.1.2 Contaminant Plume Assessment

As noted in Section 4.0, ground-water contamination assessment monitoring has been in progress since January 1986 at the S-3 Site, Oil Landfarm, and Bear Creek Burial Grounds (Figure 4-1) RCRA TSD facilities, and since January 1988 at two SWMUs, the Rust Spoil Area and Spoil Area I (Figure 4-2). Data provided by these monitoring efforts have served to confirm the following observations; (1) the ground-water flow system at each site displays similar patterns of contaminant migration (i.e towards the Maynardville Limestone), (2) the bulk of the ground-water contamination at the three RCRA TSD units is generally restricted to the low permeability shales which underlie each site, (3) contamination from the S-3 Site has migrated into both the Bear Creek and UEFPC hydrogeologic regimes, and (4) contaminants originating from at least two RCRA TSD units (S-3 Site and Oil Landfarm) and possibly the Rust Spoil Area SWMU have entered the Maynardville Limestone and migrated southwest down Bear Creek Valley.

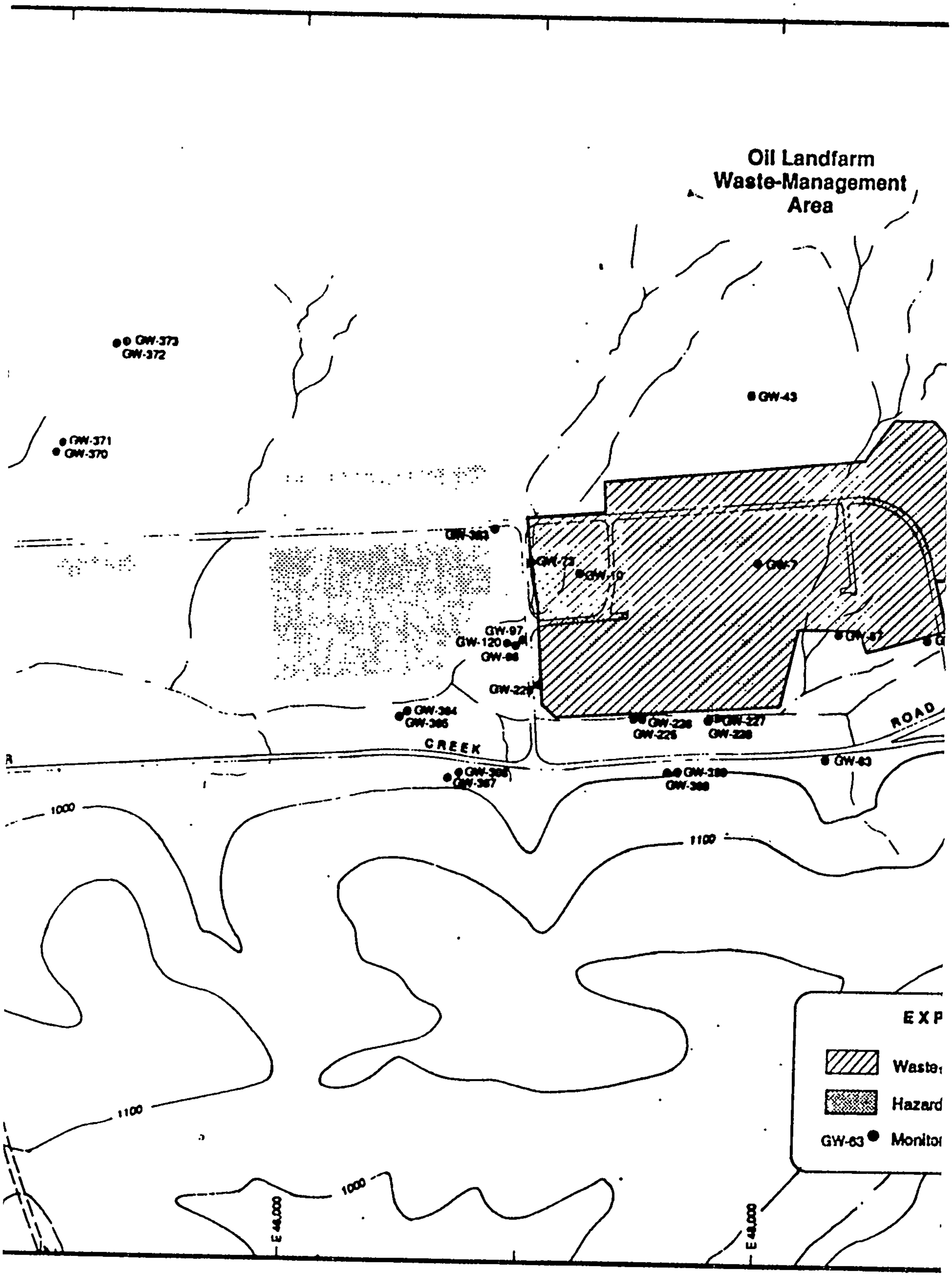
In light of these observations, it is clear that the site-specific monitoring activities should be incorporated into a single contamination assessment program for the entire Bear Creek hydrogeologic regime. The goals of this program are (1) to coordinate and standardize all assessment monitoring activities at all sites in the Bear Creek hydrogeologic regime, and (2) to redirect monitoring efforts towards areas where additional water-quality and hydrogeologic data are needed.

In order to incorporate site-specific monitoring activities into a single monitoring program, the site-specific monitor-well networks must first be combined into a regime-wide monitor-well network. The location of wells monitored in 1989 is shown on Figure 5-1. The proposed 1990 well network, including locations for proposed new wells, for the Bear Creek hydrogeologic regime is shown on Figure 5-2. Details regarding the depth, aquifer zone (unconsolidated or bedrock), and formation monitored by each well included in the regime-wide monitor-well network are summarized on Table 5-1.

A comparison of Figures 5-1 and 5-2 shows that the number of wells located adjacent to or in close proximity of the RCRA TSD units has been significantly reduced. Further assessment monitoring of these wells is not warranted because most have been sampled on a regular basis since 1985, the picture of the contaminant plume presented by



Burial Grounds
Waste-Management
Area
Plant North
North
34°
N 30,000
N 28,000
E 42,000
E 44,000
GW-342
GW-182
GW-42
GW-242
GW-40
GW-82
GW-14
GW-374
GW-47
GW-71
GW-72
GW-375
GW-237
GW-119
GW-118
GW-86
GW-45
GW-117
GW-94
GW-61
GW-58
GW-128
BEAR
CREEK
900
1100


Oil Landfarm
Waste-Management
Area
GW-373
GW-372
GW-371
GW-370
GW-43
GW-363
GW-73
GW-10
GW-7
GW-97
GW-120
GW-96
GW-229
GW-384
GW-385
GW-228
GW-225
GW-227
GW-226
GW-63
CREEK
ROAD
1000
1100
E 46,000
E 48,000
EXP
Waste
Hazard
GW-63
Monitor

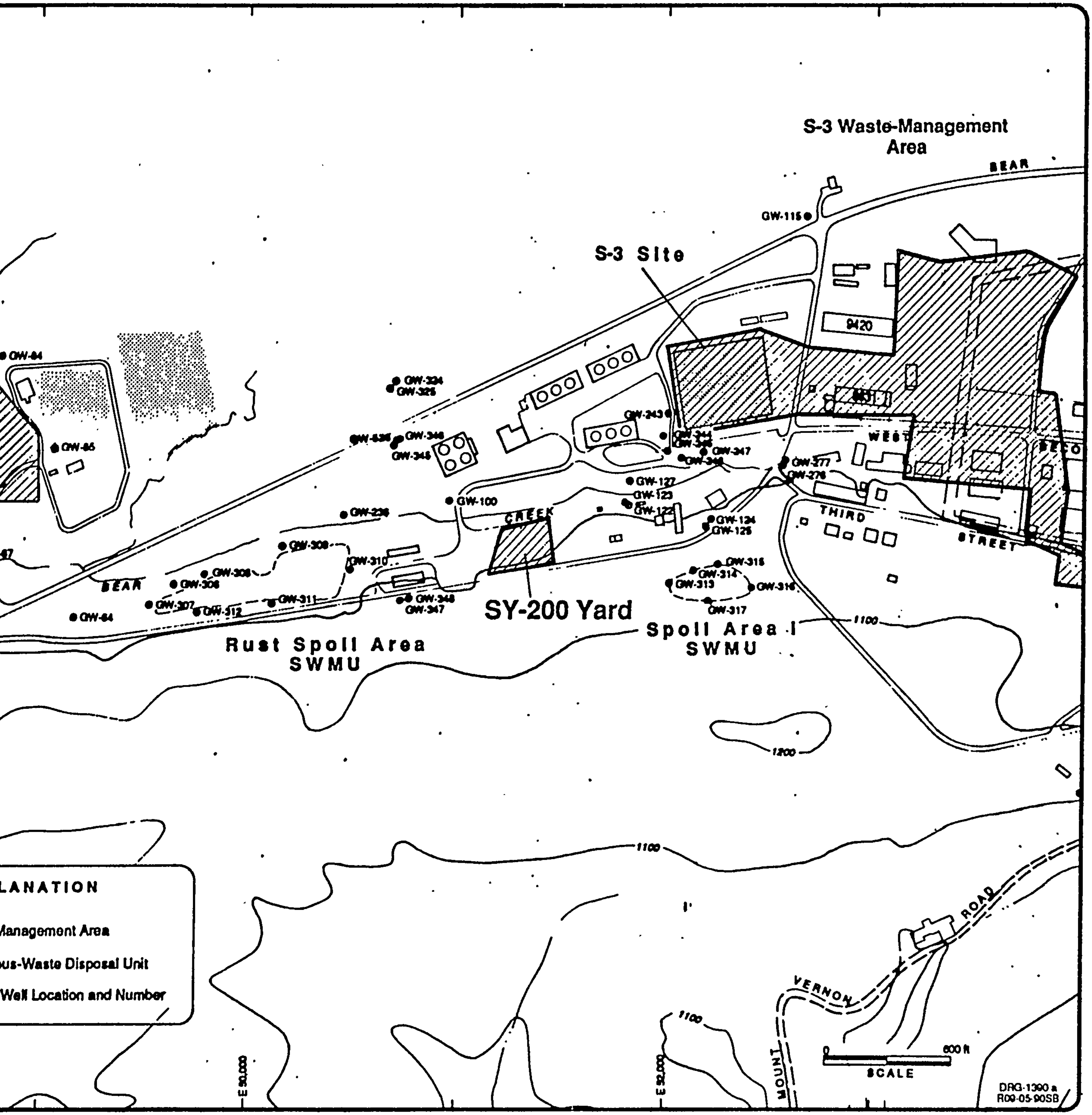
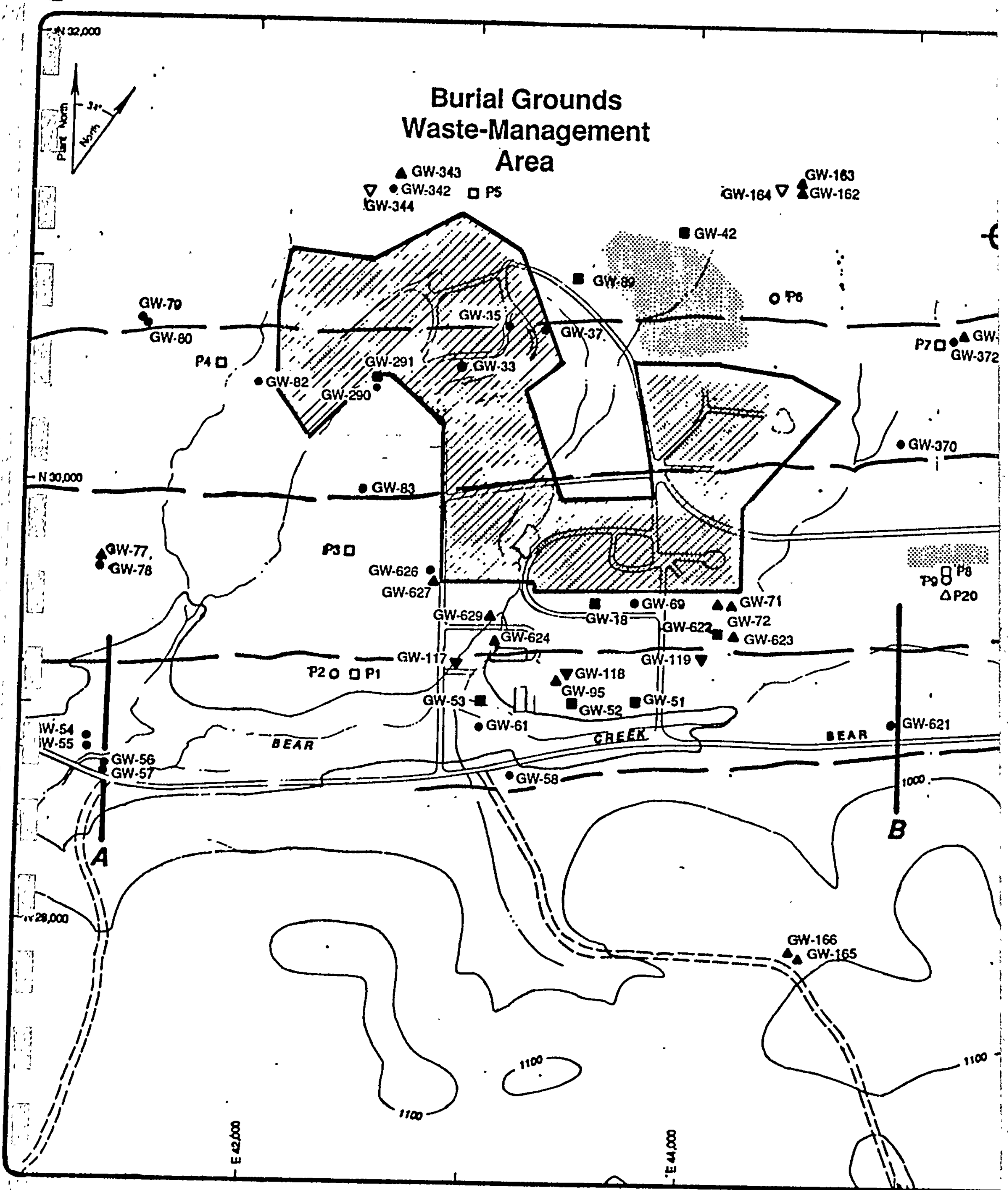
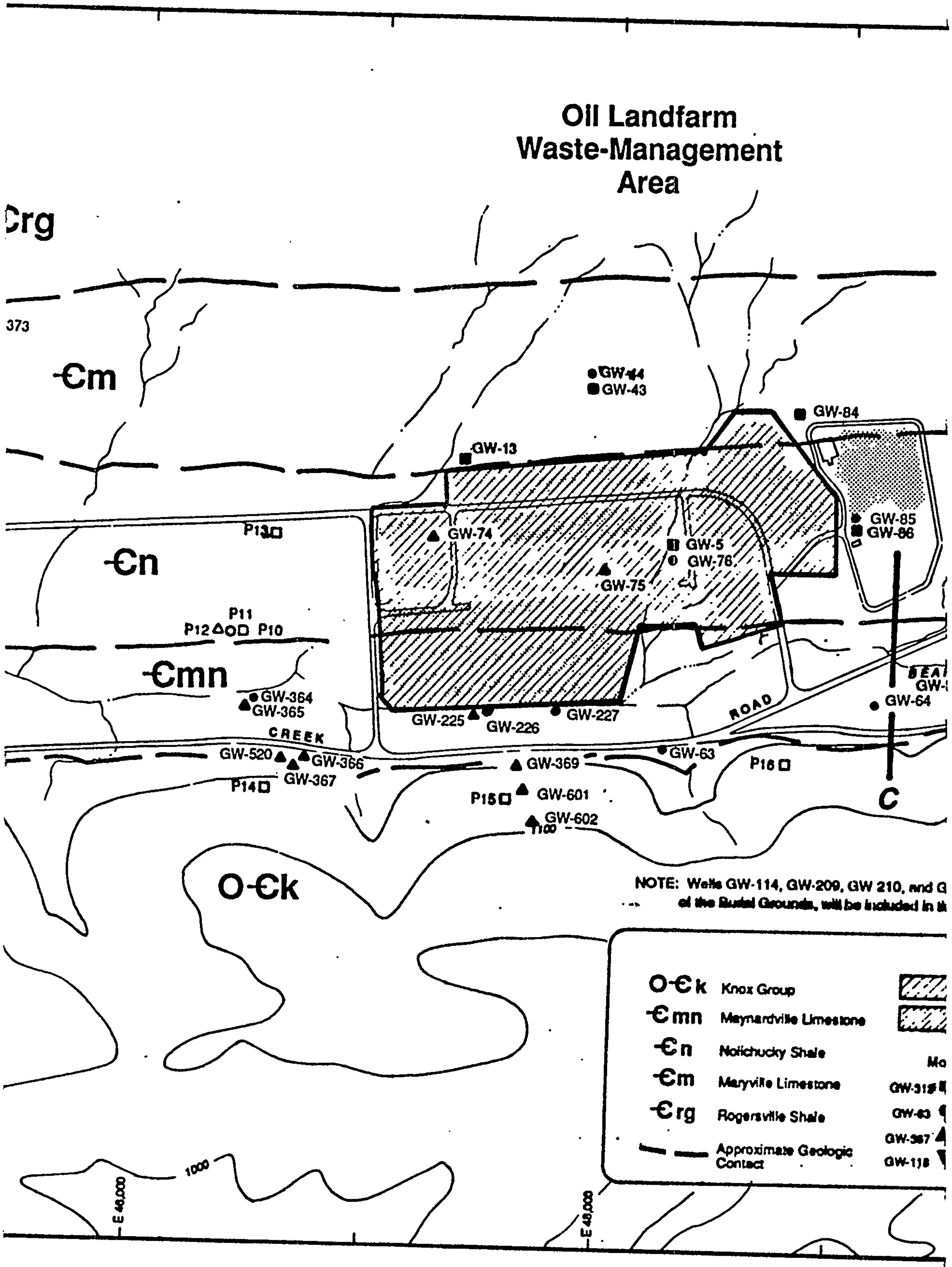


Figure 5-1. Monitor-Wells Included in the 1989 RCRA Ground-Water Quality Assessment Monitoring Program in Bear Creek Valley



Burial Grounds
Waste-Management
Area
N 32,000
N 30,000
N 28,000
E 42,000
E 44,000
Plant North
North
GW-343
GW-342
GW-344
P5
GW-163
GW-164
GW-162
GW-42
GW-89
P6
GW-79
GW-80
GW-35
GW-37
P7
GW-372
P4
GW-291
GW-33
GW-82
GW-290
GW-370
GW-83
GW-77,
GW-78
P3
GW-626
GW-627
P9
P8
P20
GW-629
GW-18
GW-69
GW-71
GW-72
GW-622
GW-623
GW-624
GW-117
GW-119
P2
P1
GW-118
GW-95
GW-53
GW-52
GW-51
GW-61
GW-621
GW-54
GW-55
BEAR
CREEK
BEAR
GW-56
GW-57
GW-58
1000
A
B
GW-166
GW-165
1100
1100
1100


Oil Landfarm
Waste-Management
Area
Crg
373
-Cm
-Cn
-Cmn
O-Ck
GW-44
GW-43
GW-84
GW-13
GW-85
GW-86
P13
GW-74
GW-5
GW-76
GW-75
P11
P12
P10
GW-364
GW-365
GW-225
GW-226
GW-227
ROAD
CREEK
GW-64
GW-63
GW-520
GW-366
GW-367
GW-369
P14
P15
GW-601
GW-602
P16
C
1100
1000
E 46,000
E 48,000
NOTE: Wells GW-114, GW-209, GW 210, and G
of the Burial Grounds, will be included in th
O-Ck Knox Group
-Cmn Maynardville Limestone
-Cn Nolichucky Shale
-Cm Maryville Limestone
-Crg Rogersville Shale
Approximate Geologic Contact
GW-63
GW-367
GW-118

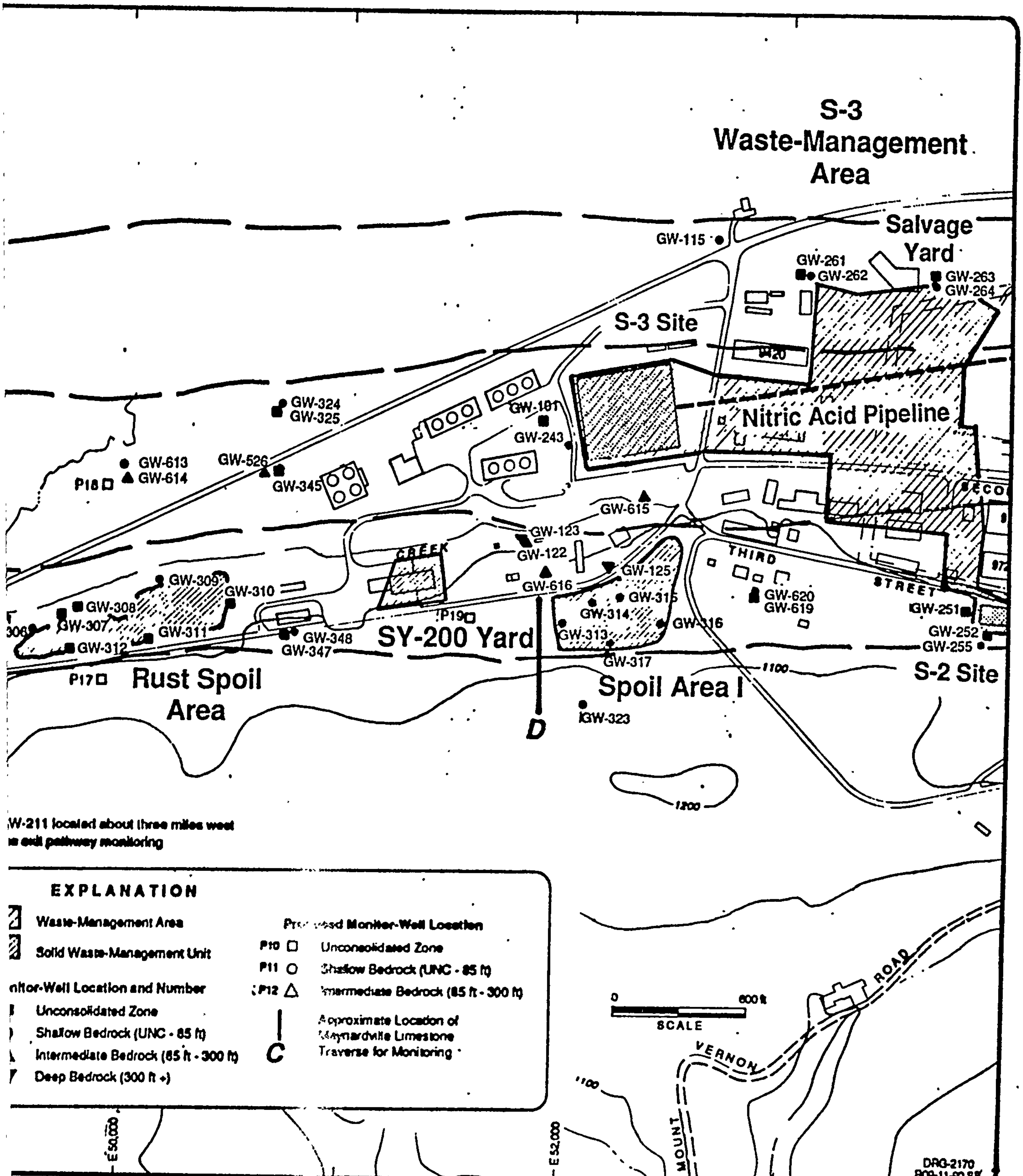


Figure 5-2. Monitor-Well Network for Assessment Monitoring in the Bear Creek Hydrogeologic Regime, 1990

Table 5-1. Monitor Wells Included in Ground-Water Quality Assessment Monitoring for the Bear Creek Hydrogeologic Regime

Well Number	Monitored Interval (depth, ft)	Screen/Open	Formation Monitored	
S-3 Site WMA				
GW-101	10.1 - 17.5	Screen	UNC	
GW-115 *(a)*	42.0 - 52.0	Screen	BDR	Ꞓm
GW-122	92.0 - 142.0	Open	BDR	Ꞓn
GW-123	522.0 - 572.0	Open	BDR	Ꞓn
GW-125	502.0 - 552.0	Open	BDR	Ꞓn
GW-243	43.2 - 77.0	Screen	BDR	Ꞓn
GW-251 *(b)*	35.0 - 51.0	Screen	BDR	Ꞓmn
GW-252 *(b)*	40.2 - 49.0	Screen	UNC	—
GW-253 *(b)*	36.2 - 50.0	Screen	BDR	Ꞓmn
GW-255 *(b)*	66.3 - 81.5	Screen	BDR	OꞒk
GW-261 *(a),(b)*	16.7 - 23.7	Screen	BDR	Ꞓm
GW-262 *(a),(b)*	57.7 - 70.6	Screen	BDR	Ꞓm
GW-263 *(b)*	23.0 - 30.8	Screen	UNC	—
GW-264 *(b)*	58.5 - 71.0	Screen	BDR	Ꞓm
GW-324 *(a)*	68.5 - 79.0	Screen	BDR	Ꞓn
GW-325 *(a)*	7.3 - 17.9	Screen	UNC	—
GW-345	16.0 - 26.0	Screen	UNC	—
GW-347	11.7 - 27.5	Screen	UNC	—
GW-348	70.2 - 80.6	Screen	BDR	Ꞓmn
GW-526	101.0 - 123.0	Open	BDR	Ꞓn
GW-613 *(c)*	31.7 - 75.2	Screen	BDR	N/A
GW-614 *(c)*	42.0 - 90.2	Screen	BDR	N/A
GW-615 *(c)*	222.5 - 245.0	Open	BDR	Ꞓn
GW-616 *(c)*	219.7 - 269.0	Open	BDR	Ꞓn
GW-617 *(b)*	6.8 - 18.0	Screen	UNC	
GW-618 *(b)*	26.0 - 37.0	Screen	BDR	Ꞓmn
GW-619 *(b)*	26.8 - 40.8	Screen	UNC	
GW-620 *(b)*	61.7 - 75.0	Screen	BDR	Ꞓmn
Spoil Area I				
GW-313	98.2 - 113.0	Screen	BDR	Ꞓmn
GW-314	101.0 - 115.0	Screen	BDR	Ꞓmn
GW-315	90.0 - 104.0	Screen	BDR	Ꞓmn
GW-316	67.5 - 80.0	Screen	BDR	Ꞓmn
GW-317 *(a)*	119.5 - 130.5	Screen	BDR	Ꞓmn
GW-323 *(a)*	94.0 - 108.0	Screen	BDR	OꞒk
Rust Spoil Area				
GW-306	48.1 - 58.1	Screen	BDR	Ꞓmn
GW-307	30.9 - 41.6	Screen	UNC	—
GW-308	22.0 - 37.7	Screen	UNC	—
GW-309	27.0 - 37.0	Screen	BDR	Ꞓmn
GW-311	25.6 - 40.3	Screen	UNC	
GW-310	21.8 - 27.1	Screen	UNC	—
GW-312	29.6 - 41.0	Screen	UNC	—
Oil Landfarm WMA				
GW-5	3.0 - 12.5	Screen	UNC	
GW-13	6.0 - 14.0	Screen	UNC	
GW-43 *(a)*	22.8 - 32.8	Screen	UNC	—
GW-44	42.5 - 70.0	Screen	BDR	Ꞓm
GW-63	27.7 - 32.7	Screen	BDR	Ꞓmn
GW-64	50.7 - 52.7	Screen	BDR	Ꞓmn
GW-74	176.5 - 200.6	Screen	BDR	
GW-75	176.5 - 199.6	Screen	BDR	Ꞓn
GW-76	67.8 - 80.3	Screen	BDR	Ꞓn
GW-84 *(a)*	46.8 52.7	Screen	UNC	—
GW-85	53.8 - 58.8	Screen	BDR	Ꞓn
GW-86	21.0 - 29.6	Screen	UNC	
GW-225	150.0 - 200.0	Open	BDR	Ꞓmn
GW-226	45.0 - 55.0	Open	BDR	Ꞓmn
GW-227	30.0 - 40.0	Open	BDR	Ꞓmn

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Table 5-1. Continued...

Well Number	Monitored Interval (depth, ft)	Screen/Open	Formation Monitored	
GW-364	49.8 - 59.8	Screen	BDR	Ꞓmn
GW-365	126.7 - 150.0	Open	BDR	Ꞓmn
GW-366	90.5 - 100.5	Screen	BDR	Ꞓmn
GW-367	125.0 - 150.0	Open	BDR	OꞒk
GW-369	115.8 - 150.2	Open	BDR	Ꞓmn
GW-520	68.0 - 80.3	Screen	BDR	OꞒk
GW-601 *(c)*	318.5 - 194.3	Open	BDR	Ꞓmn
GW-602 *(c)*	356.0 - 212.0	Open	BDR	Ꞓmn
Bear Creek Burial Grounds WMA				
GW-18	12.0 - 18.9	Screen	BDR	Ꞓn
GW-33	30.0 - 37.9	Screen	BDR	Ꞓm
GW-35	37.5 - 60.3	Screen	BDR	Ꞓm
GW-37	42.0 - 68.7	Screen	BDR	Ꞓm
GW-42 *(a)*	13.4 - 28.7	Screen	UNC	—
GW-51	2.0 - 11.2	Screen	UNC	—
GW-52	4.0 - 19.5	Screen	UNC	—
GW-53	11.4 - 32.8	Screen	BDR	Ꞓmn
GW-54	31.1 - 37.2	Screen	BDR	Ꞓmn
GW-55	15.5 - 20.0	Screen	BDR	Ꞓmn
GW-56	49.1 - 55.2	Screen	BDR	Ꞓmn
GW-57	17.5 - 22.8	Screen	BDR	Ꞓmn
GW-58	42.2 - 44.2	Screen	BDR	Ꞓmn
GW-61	19.6 - 24.6	Screen	BDR	Ꞓmn
GW-69	79.0 - 99.2	Screen	BDR	Ꞓn
GW-71	195.1 - 219.0	Screen	BDR	Ꞓn
GW-72	84.5 - 98.4	Screen	BDR	Ꞓn
GW-77	87.4 - 100.3	Screen	BDR	Ꞓn
GW-78	11.7 - 21.1	Screen	BDR	Ꞓn
GW-79	49.9 - 64.9	Screen	BDR	Ꞓrg
GW-80	20.8 - 29.7	Screen	BDR	Ꞓrg
GW-82	29.4 - 34.4	Screen	BDR	Ꞓm
GW-83	19.9 - 29.5	Screen	BDR	Ꞓn
GW-89	20.0 - 25.0	Screen	UNC	—
GW-95	134.8 - 155.8	Screen	BDR	Ꞓmn
GW-117	480.0 - 530.0	Open	BDR	Ꞓn
GW-118	525.0 - 575.0	Open	BDR	Ꞓn
GW-119	460.0 - 510.0	Open	BDR	Ꞓn
GW-162 *(a)*	92.0 - 125.0	Open	BDR	Ꞓpv
GW-163	208.0 - 225.0	Open	BDR	Ꞓr
GW-164	370.0 - 405.0	Open	BDR	Ꞓr
GW-165	276.0 - 325.0	Open	BDR	OꞒk
GW-166	380.0 - 385.0	Open	BDR	OꞒk
GW-209	42.0 - 48.1	Screen	BDR	Ꞓr
GW-210	104.0 - 124.0	Open	BDR	Ꞓr
GW-211	404.0 - 410.0	Open	BDR	Ꞓr
GW-290	19.3 - 32.5	Screen	BDR	Ꞓm
GW-291	6.7 - 14.2	Screen	UNC	—
GW-342 *(a)*	65.0 - 75.0	Screen	BDR	Ꞓpv
GW-343	170.0 - 185.0	Open	BDR	Ꞓr
GW-344	301.0 - 316.0	Open	BDR	Ꞓr
GW-370	22.5 - 32.5	Screen	BDR	Ꞓm
GW-372 *(a)*	41.0 - 51.0	Screen	BDR	Ꞓm
GW-373 *(a)*	123.0 - 158.0	Open	BDR	Ꞓm
GW-621 *(c)*	24.8 - 40.5	Screen	BDR	N/A
GW-622 *(c)*	8.6 - 18.7	Screen	UNC	—
GW-623	219.0 - 349.0	Open	BDR	Ꞓn
GW-624 *(c)*	16.9 - 27.2	Screen	UNC	—
GW-626 *(c)*	67.7 - 254.0	Screen	BDR	N/A
GW-627 *(c)*	77.7 - 270.0	Open	BDR	N/A
GW-629	262.3 - 312.0	Open	BDR	Ꞓn

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(b) - Located within UEFPC Hydrogeologic Regime.
(a) - Background Well
(c) - Installed in 1989.
(d) - Sampled as part of DNAPL investigation.
N/A - Information Not Available.
UNC - Unconsolidated Zone

OꞒk - Knox Group
Ꞓmn - Maynardville Limestone
Ꞓn - Nolichucky Shale
Ꞓm - Maryville Limestone
Ꞓpv - Pumpkin Valley Shale
BDR - Bedrock Zone

these wells has remained relatively unchanged, and further monitoring may siphon man-power and funding resources that could be more effectively applied elsewhere. However, once Post-Closure Permits are issued or as the monitoring program evolves, some wells adjacent to RCRA TSD units may be incorporated back into the monitoring program to maintain compliance with the permit (e.g. compliance point wells).

In addition to the regime-wide monitor well network, a single suite of contamination assessment parameters and a quarterly sampling frequency will also be employed. Listed on Table 5-2, this suite of parameters was prepared from the site-specific lists of assessment parameters contained in the 1988 GWQARs for the S-3 Site, Oil Landfarm, and Bear Creek Burial Grounds. All constituents present in the site-specific contaminant plumes are included on Table 5-2 although not all of these constituents have been detected in ground water at each site. In addition to this standard suite of parameters some wells will also be sampled for selected radionuclides. The utilization of a single suite of assessment parameters will standardize monitoring activities, and will facilitate a more complete evaluation of the extent of each constituent in ground water throughout the Bear Creek hydrogeologic regime.

In conjunction with the hydrogeologic regime monitor-well network and standardized list of assessment parameters, the overall direction of monitoring efforts in the Bear Creek hydrogeologic regime will be focused on defining horizontal and vertical contamination "zero lines." The horizontal extent of ground-water contamination in the shale formations of the Conasauga Group in the Bear Creek hydrogeologic regime has essentially been defined; however, the EPA still has questions regarding the vertical extent of contamination in these shales. These areas will therefore be the focus of future monitoring efforts.

Table 5-2. Standardized List of Ground-Water Quality Assessment Parameters for the Bear Creek Hydrogeologic Regime

Volatile Organics

- Acetone
- Bromodichloromethane
- Benzene
- Bromoform
- Bromomethane
- 2-Butanone
- Carbon disulfide
- Carbon tetrachloride
- Chlorobenzene
- Chloroethane
- Chloroform
- Chloromethane
- Dibromochloromethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethene
- 1,2-Dichloroethene (total)
- 1,2-Dichloropropane
- cis-1,3-Dichloropropene
- trans-1,3-Dichloropropene
- Ethylbenzene
- 2-Hexanone
- 4-Methyl-2-pentanone
- Methylene chloride
- Styrene
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethene
- Toluene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethene
- Vinyl Acetate
- Vinyl Chloride
- Xylenes (total)

Elements

ICP Metals Scan

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Calcium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Potassium
- Selenium
- Silicon
- Silver
- Sodium
- Strontium
- Thorium
- Vanadium
- Zinc

ASS Metals

- Cadmium
- Chromium
- Lead

Others

- Uranium (Fluorometric)
- Mercury

Radiochemical Parameters

- Gross Alpha
- Gross Beta

Miscellaneous Parameters

- pH
- Specific Conductance
- Total Suspended Solids
- Total Dissolved Solids
- Turbidity
- Nitrate (as N)
- Alkalinity Bicarbonate
- Alkalinity Carbonate
- Chloride
- Fluoride
- Sulfate

Field Parameters

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen
- Redox
- Water Level

The contamination assessment program will be focused strictly on ground-water contamination in the Bear Creek hydrogeologic regime. The extent of contamination originating from the S-3 Site would be evaluated under two assessment programs; one for the Bear Creek hydrogeologic regime and one for the UEFPC hydrogeologic regime (see Section 5.2).

5.1.3 Exit Pathway Monitoring

The Maynardville Limestone serves as the primary pathway for the migration of ground-water contaminants in the Bear Creek hydrogeologic regime. Furthermore, as discussed in Section 3.2, there is a significant degree of hydraulic interconnection between surface water in Bear Creek and ground water in the Maynardville. Thus, a program involving the collection of water samples from selected monitor wells, springs, and surface-water sampling points will be initiated to monitor and evaluate the quality of surface water and ground water moving through and eventually exiting the Bear Creek Valley.

5.1.3.1 Ground Water

Exit pathway monitoring of ground water will be accomplished through the installation of monitor-well clusters along parallel traverses oriented perpendicular to the strike of the Maynardville. The proposed locations of these traverses are shown on Figure 5-2. Existing assessment wells which monitor the Maynardville will also be utilized as part of the exit pathway monitoring system. The development of solution cavities in the shallow bedrock zone of the Maynardville has been well documented. Preliminary data also suggest that specific stratigraphic zones may be susceptable to solution activity at depth.

The specific well locations and target depths of the monitor-well clusters will be based on a thorough evaluation of the existing data available for the Maynardville. In order to define target stratigraphic zones core obtained from the Maynardville during previous drilling programs will be carefully examined in conjunction with the results of packer tests and a review of all available drilling, lithologic, and geophysical logs. Zones within the Maynardville that appear to be subject to solution cavity development will be delineated. Monitor wells will then be installed at each cluster location to monitor the down-dip extension of these stratigraphic zones as well as the shallow bedrock. Figure 5-3 illustrates the conceptual well placement of a well cluster traverse across strike of the Maynardville.

In addition to the monitor wells, quarterly sampling of springs SS-1, SS-4, SS-5, SS-6, and SS-8 is also needed to monitor the quality of ground-water migrating through the Maynardville Limestone. The locations of these springs are shown on Figure 5-4 and the rationale for their inclusion in the exit pathway monitoring program is summarized on Table 5-3. Samples from the springs will also be analyzed for the standard list of contamination assessment parameters (Table 5-2) and isotopic uranium.

5.1.3.2 Surface Water

Bear Creek has been the subject of numerous studies and hydrologic and geochemical investigations since 1985. Continuous records of stream flow have been obtained by the United States Geological Survey (USGS) at monitoring station Bear Creek Kilometer (BCK) 4.55 (a NPDES site) since March 1985, and at BCK 6.24 and BCK 3.88 since September and October 1986, respectively (Martin Marietta Energy Systems, Inc. 1988) (Figure 5-5). The USGS has also monitored flows in three tributaries (NT-14, NT-15, and ET-1) since October 1986 (Figure 5-5). In addition, weekly stream flow measurements were conducted at 19 locations by personnel from the Oak Ridge National Laboratory (ORNL) between March 19, 1984 and October 16, 1987 (Martin Marietta Energy Systems, Inc.1988). Since 1987, monthly stream flow measurements have been obtained by Y-12 Plant personnel.

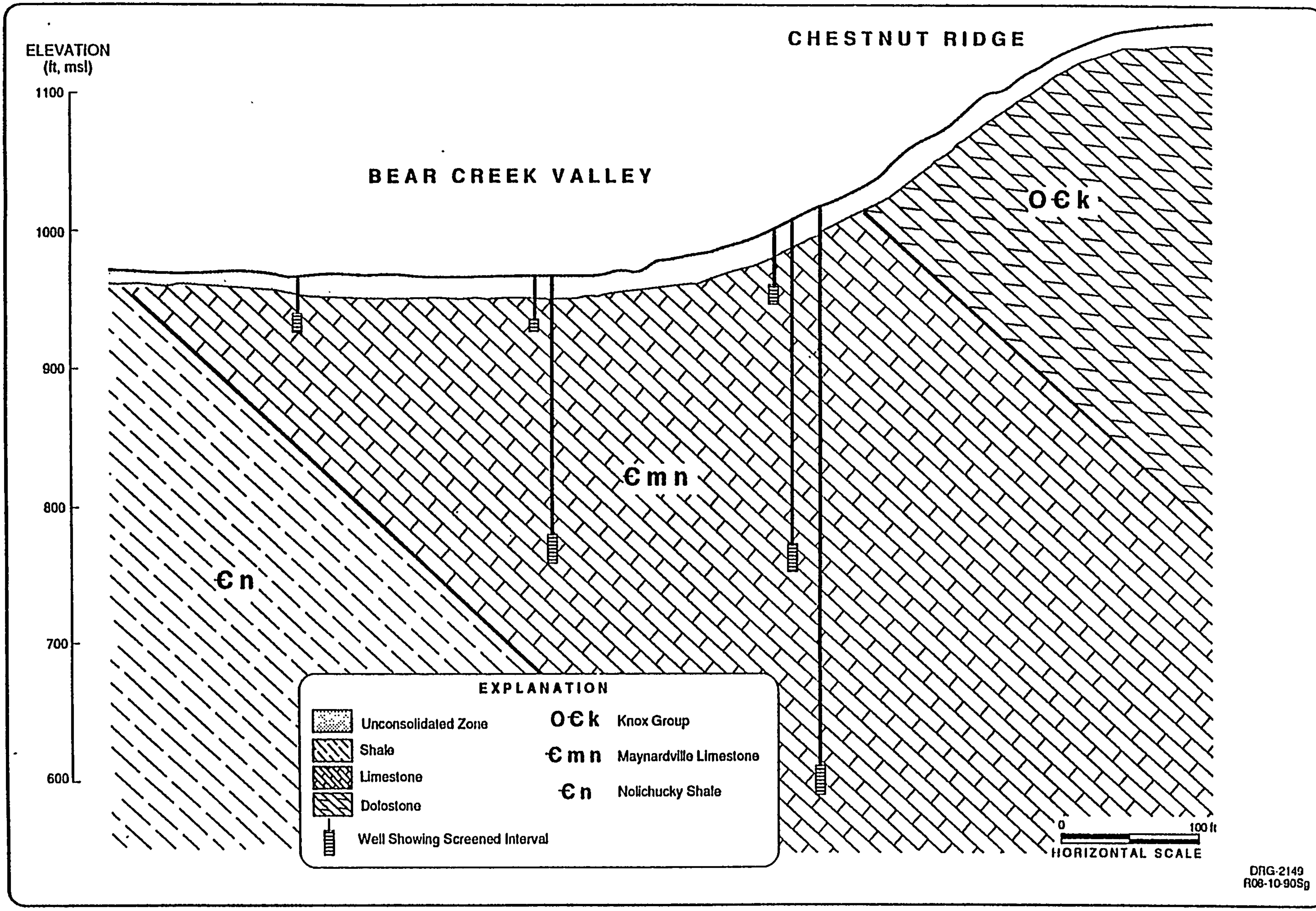

Figure 5-3. Conceptualized Well Placement for Exit Pathway Ground-Water Monitoring at the Y-12 Plant

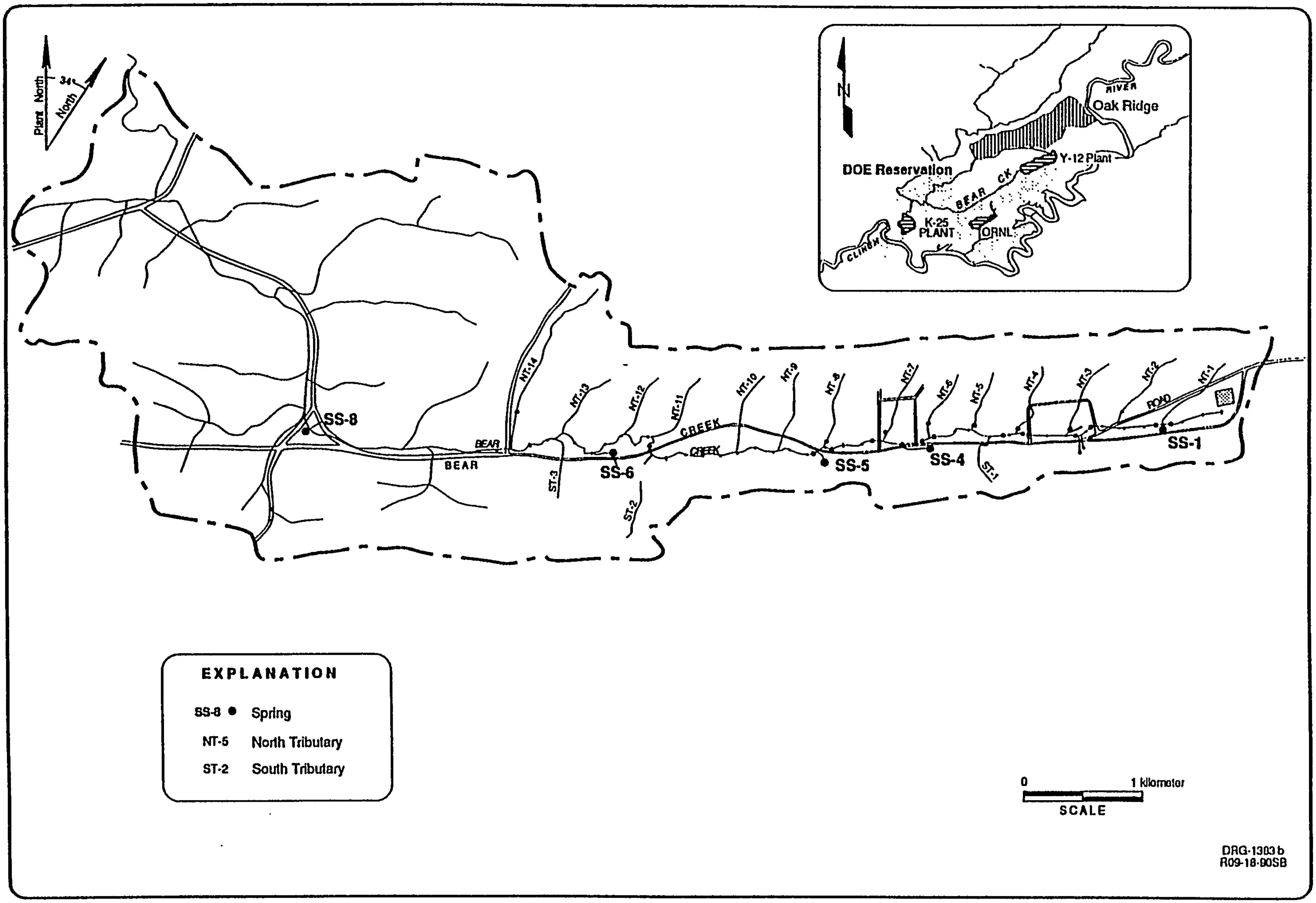

Figure 5-4. Springs Included in the Exit Pathway Monitoring Program for the Bear Creek Hydrogeologic Regime

Table 5-3. Description of Springs Proposed for Inclusion in the Exit-Pathway Monitoring Program for the Bear Creek Hydrogeologic Regime

Spring No.	Description
SS-1	Spring which enters Bear Creek from the south at BCK-12.38 immediately upstream of the Rust Spoil Area. Water discharged by the spring has shown evidence of contamination with nitrate and uranium.
SS-4	Spring which enters Bear Creek from the south at BCK-10.14. Thought to represent reemergence of the Bear Creek surface water which typically disappears in the "losing reach" of Bear Creek upstream of this spring. Water discharged by the spring has shown evidence of contamination with nitrate and uranium.
SS-5	Spring which enters Bear Creek from the south at BCK-9.41 downstream of Bear Creek Road crossing. Water discharged by the spring has shown evidence of contamination with nitrate and uranium.
SS-6	Spring which enters Bear Creek from the south at BCK-7.11. This spring has not been previously sampled.
SS-8	Spring which enters Bear Creek from the south at BCK-4.56 adjacent to and upstream of NPDES monitoring station. Water discharged by the spring has not shown evidence of contamination. Spring contributes considerable flow to Bear Creek.

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NOTE: Modified from Table 8-1 in "RCRA Facility Investigation Plan for Bear Creek, U.S. DOE Y-12 Plant, Oak Ridge, Tennessee", Martin Marietta Energy Systems, Inc., Environmental Management Department, Health, Safety, Environment, and Accountability Division (Y/TS-417).

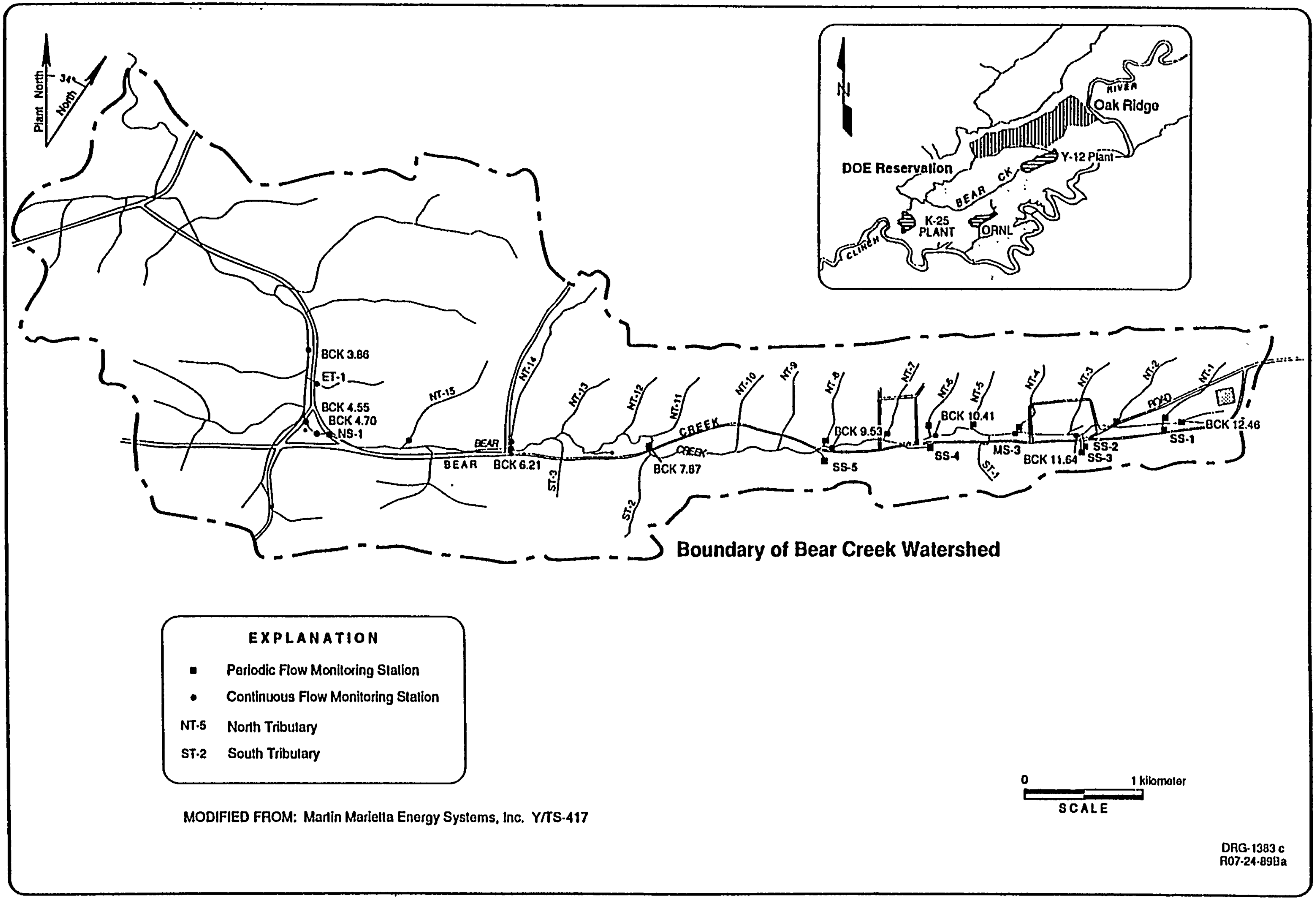

Figure 5-5. Bear Creek Hydrologic Monitoring Stations

Water-quality monitoring in Bear Creek has been conducted by a number of investigators, including the USGS, ORNL, TVA, Y-12 Plant personnel, and several private consultants (Roy F. Weston, Inc., Bechtel, Inc., and Geraghty & Miller, Inc.). Results of these investigations have shown Bear Creek to contain aqueous phase VOCs in its upper reaches with the highest concentrations found near the Bear Creek Burial Grounds. A number of inorganic contaminants have also been detected in Bear Creek, particularly in its upper reaches where acidic seepage from the S-3 Site produced high concentrations of dissolved inorganic salts (Martin Marietta Energy Systems, Inc.1988). However, the concentrations of the inorganic constituents sharply decreased after neutralization of the S-3 Site wastes in 1983. Nonetheless, the contribution of solutes from the S-3 Site ground-water contaminant plumes still dominate the inorganic chemistry of upper Bear Creek (Martin Marietta Energy Systems, Inc. 1988).

The above described investigations were intensive, short-term data acquisition efforts initiated to obtain fundamental hydrologic and geochemical data that were not previously available. However, for the purposes of the surface-water exit pathway monitoring program for Bear Creek a less intensive long-term monitoring effort is needed. This program involves the quarterly collection of surface water samples from one background (uncontaminated) site and four downstream (potentially contaminated) sites. The locations of these monitoring sites are shown on Figure 5-6. As shown, background surface-water samples will be collected from one site (NT-13) located in a tributary to Bear Creek that has not been impacted by waste management activities. The four downstream locations are; BCK-0.63, BCK-4.55, BCK-9.4, and BCK-11.97. The rational for the selection of these sampling locations is provided on Table 5-4.

Samples from each location will be collected quarterly. All samples will be analyzed for the standard suite of constituents (Table 5-2) and isotopic uranium. In addition, the rate of flow in the creek should also be measured at the time of sample

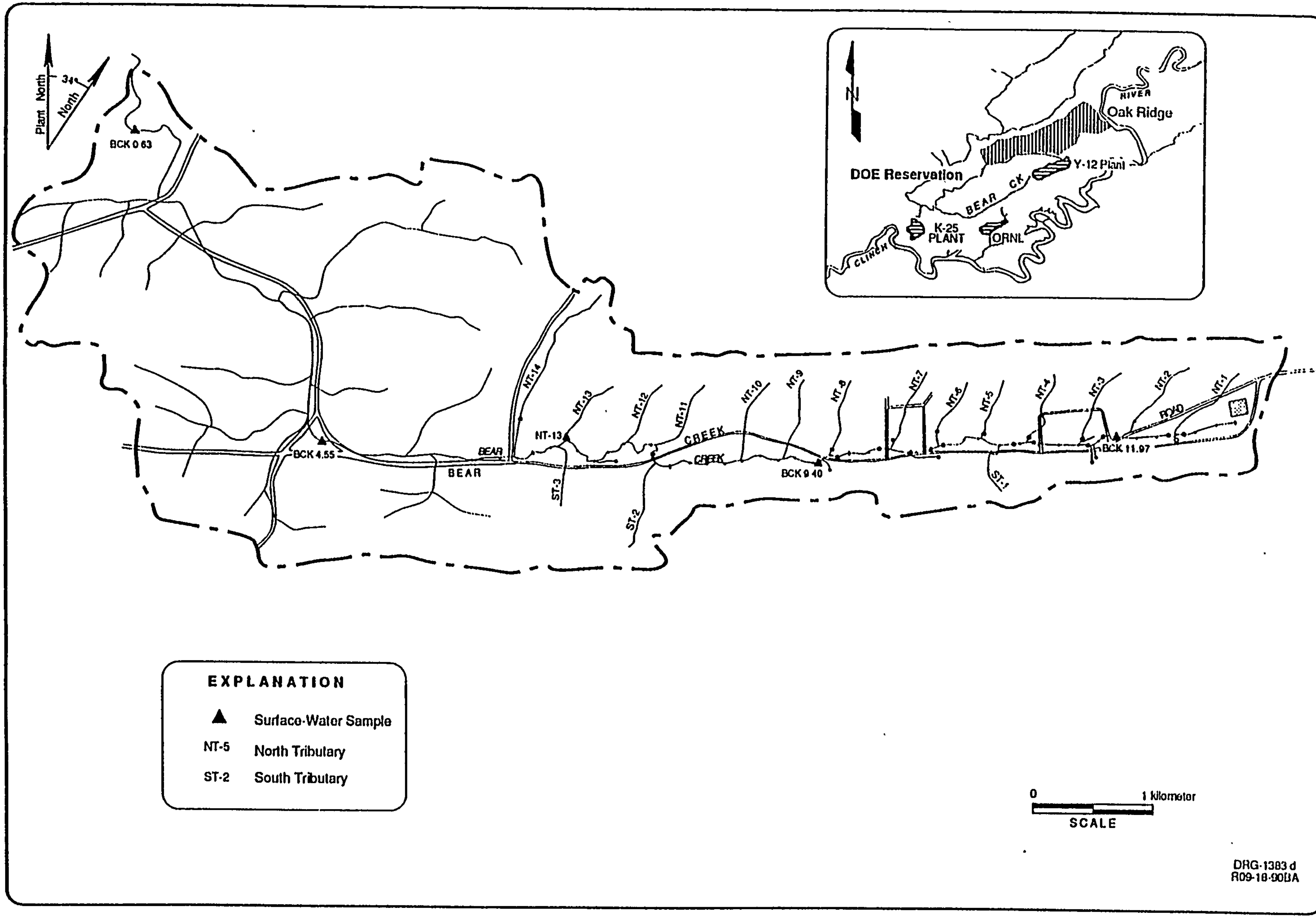

Figure 5-6. Surface-Water Sampling Stations Included in the Exit Pathway Monitoring Program for the Bear Creek Hydrogeologic Regime

Table 5-4. Description of Proposed Surface-Water Monitoring Stations Included in the Exit-Pathway Monitoring Program for the Bear Creek Hydrogeologic Regime

Monitoring Station	Description
NT-13 (Background)	Tributary which enters Bear Creek at BCK-6.76 and represents drainage from a relatively undisturbed catchment that has not been impacted by waste-disposal activities in Bear Creek Valley.
BCK-0.63	Upstream of the confluence with East Fork Poplar Creek. Represents essentially all surface-water discharge from the Bear Creek watershed.
BCK-4.55	Location of NPDES monitoring site 304. Site represents surface-water discharge from at least one area of the Bear Creek floodplain known to be contaminated with uranium and PCBs.
BCK-9.40	Represents surface-water discharge from area of Bear Creek watershed impacted by waste-disposal activities.
BCK-11.97	Represents surface-water discharge from area of S-3 Site, Rust Spoil Area, and Spoil Area I. Includes discharge from Tributary NT-1 and Spring SS-1, which probably receives ground-water inputs from the S-3 Site contamination plume.

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NOTE: Modified from Table 8.1 in "RCRA Facility Investigation Plan for Bear Creek, U.S. DOE Y-12 Plant, Oak Ridge, Tennessee", Martin Marietta Energy Systems, Inc., Environmental Management Department, Health, Safety, Environment, and Accountability Division (Y/TS-417).

collection. Sampling procedures, stream-flow measurement techniques, and laboratory analytical methods that will be utilized are outlined in Section 6.0.

5.1.4 Recordkeeping and Reporting

Energy Systems currently employs recordkeeping practices that have proven acceptable to both the TDHE and the EPA. No changes to these practices is recommended. As noted in Section 2.3, however, site-specific reports have become increasingly cumbersome and inadequate forums for presentation of ground-water conditions in areas where contaminant plumes have overlapped or intermingled. To alleviate this problem, a two part report will be prepared annually for the entire Bear Creek hydrogeologic regime. The reporting requirements for RCRA annual asserssments include the results of quarterly sampling and analysis, and the rate of contaminant migration. To meet the required annual March reporting deadline and allow sufficient time for data interpretations, the GWQAR will be presented in two parts; Part I will be submitted by March of each year and consist of tabulated water-quality data and an evaluation of the rate of contaminant migration, and Part II will address data interpretations, the extent and severity of contaminant plumes, and monitoring program recommendations.

The proposed outline for Part I and Part II of the GWQAR is shown on Tables 5-5 and 5-6 respectively. Note that the extent of ground-water contamination will be presented in a "contaminant specific" framework. For example, the section regarding nitrate contamination will present the extent of nitrate contamination throughout the Bear Creek hydrogeologic regime, as well as discuss the site-specific contaminant contribution. This approach, however, will in no way affect the presentation of site-specific conditions; the site-specific extent of ground-water contamination will be thoroughly discussed, and will be presented in a context in which the contribution of the site to the regime-wide extent of contamination can be more easily demonstrated.

Table 5-5. Outline for the Ground-Water Quality Assessment Report, Part I Ground-Water Quality Data and Rate of Contaminant Migration for the Bear Creek Hydrogeologic Regime

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Table 5-6. Outline for the Ground-Water Quality Assessment Report, Part II
Data Interpretations and Recommendations

- 1.0 Introduction
- 2.0 Background
  - 2.1 Waste-Site Descriptions
  - 2.2 Geology
  - 2.3 Ground-Water System
  - 2.4 Surface-Water System
- 3.0 Ground-Water Quality Assessment
  - 3.1 Interpretive Assumptions
    - 3.1.1 Major Ions
    - 3.1.2 Metals
    - 3.1.3 Volatile Organic Compounds
    - 3.1.4 Radiochemical Parameters
  - 3.2 Background Conditions
    - 3.2.1 Background Water Quality
  - 3.3 Extent of Ground-Water Contamination
    - 3.3.1 Nitrate
      - 3.3.1.1 Hydrogeologic Regime
      - 3.3.1.2 Site Specific
    - 3.3.2 Metals
      - 3.3.2.1 Hydrogeologic Regime
      - 3.3.2.2 Site Specific
    - 3.3.3 Volatile Organic Compounds
      - 3.3.3.1 Hydrogeologic Regime
      - 3.3.3.2 Site Specific
    - 3.3.4 Radionuclides
      - 3.3.4.1 Hydrogeologic Regime
      - 3.3.4.2 Site Specific
- 4.0 Surface-Water Quality Assessment
- 5.0 Conclusions
- 6.0 Recommendations
- 7.0 References

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Because contaminants from the Y-12 Plant have been released into Bear Creek, Bear Creek has been identified as a SWMU. In December 1988, an RFI Plan was submitted for Bear Creek containing detailed surface water quality and flow data. The primary forum for Bear Creek monitoring data will therefore be the RFI. However, due to the interaction of the surface water and ground-water system, and for completeness and consistency in data management, Bear Creek water-quality data will also be addressed in the GWQAR for the Bear Creek hydrogeologic regime.

5.2 UPPER EAST FORK POPLAR CREEK HYDROGEOLOGIC REGIME

As noted in Section 2.3, efforts to determine the extent of ground-water contamination at the Y-12 Plant have generally been directed at RCRA interim status TSD units located in Bear Creek Valley west of the main Plant area and on Chestnut Ridge. In the UEFPC hydrogeologic regime, contamination assessment activities have concentrated on three primary areas; near the west end of the regime at SWMUs included in the S-3 Site WMA, at mercury contaminated areas generally located in the west-central portion of the Y-12 Plant, and at New Hope Pond near the east end of the regime. Thus, comparatively little information is available regarding the extent of ground-water contamination in a major portion of the UEFPC hydrogeologic regime. Compounding this situation is the large number of potential contaminant source areas (e.g. SWMUs, CERCLA sites, and USTs) located in the UEFPC hydrogeologic regime.

Contaminant source identification plays a key role in the monitoring program for the UEFPC hydrogeologic regime because all the wastes sites that may have released contaminants to the environment in the regime have not yet been identified. As per regulatory requirements, specific actions that will be initiated to determine if contaminants have been released at each site must be presented in a site-specific work plan (e.g. RFI work plans for SWMUs) to be submitted for approval by the EPA or TDHE. Although work plans have already been prepared for several SWMUs and USTs in the UEFPC hydrogeologic regime, work plans for most of the sites have not been prepared, or are in the preliminary stages of development. Work plans not previously submitted will employ the standardized technical approach outlined in Sections 5.2.1 and 5.2.2, and where possible, those work plans which have already been submitted to the EPA will be modified, if necessary, to reflect this proposed approach. The monitoring program designed to assess the extent of ground-water contamination throughout the UEFPC hydrogeologic regime is intended to collectively address releases from all leaking waste sites. Thus, no ground-water investigation will be outlined in site-specific work plans; each plan should reference this program as the mechanism for ground-water investigation.

Monitoring for off-site migration of contaminants is of primary importance for the DOE and Energy Systems. Current efforts to monitor the quality of surface water exiting the UEFPC hydrogeologic regime are extensive and no additional efforts are proposed. There are several wells which monitor the Maynardville Limestone, the major transport pathway for ground water, in the UEFPC hydrogeologic regime. Continued monitoring of these wells and the installation of an expanded well network for exit pathway ground-water monitoring are proposed. Details for these activities are provided in Section 5.2.2.

The ground-water contaminant plume assessment monitoring program in the UEFPC hydrogeologic regime will be accomplished in three phases. Phase I is intended to delineate the horizontal extent of contamination; Phase II is directed at determining the vertical extent of contamination including investigating the occurrence of dense nonaqueous phase liquids (DNAPLs); and Phase III is directed at the identification of all hazardous constituents present in the contaminant plumes and the further delineation of the horizontal and vertical extent of contaminant plumes where needed. Exit pathway monitoring data will also be incorporated into contaminant plume assessment. Details for this approach are provided in Section 5.2.3.

5.2.1 Contaminant Source Identification

A phased investigative approach will be employed to identify sites which have released contaminants to the surrounding soils, surface water, and ground water in the UEFPC hydrogeologic regime. During the investigation of the site, soil samples will be collected and analyzed for the waste products or constituents handled at the site. If these analyses indicate that contaminants are present in the soils, ground-water samples will be collected from piezometers to determine if the contaminants have also entered the ground-water system underlying the site. Results of the analyses will then be used to evaluate the need to further investigate contaminant releases to the ground-water system. Details for this approach are provided in the following sections.

5.2.1.1 Soil Sampling

The collection and analysis of soil samples is the first step in identifying waste sites that have released contaminants into the UEFPC hydrogeologic regime. This approach is generally consistent with work plans for SWMUs and USTs that have already been submitted to the EPA and TDHE. Specific details, such as sampling locations, are therefore reserved for these site-specific plans. Soil boring methods and soil sampling procedures and protocols are discussed in Section 6.1.1.

The soil samples collected at each site have been or will be analyzed for the constituents specified in the site-specific work plan (e.g. an RFI). In general, selection of analytes is based upon the types of wastes handled at the site. Results of these analyses will be utilized on a site-by-site basis to evaluate closure options, interim corrective measures (e.g. removal of contaminated soils or free product recovery), and the need for investigation for releases to ground-water. However, if the soil samples are free of contamination, then further investigation of contaminant releases at the site will be terminated.

5.2.1.2 Piezometer Installation and Ground-Water Sampling

If results of the analyses of the soil samples indicate that contaminants have been released from a site, piezometers will be installed at that site to determine if these contaminants have entered the ground-water system. To accomplish this objective, one piezometer will be installed immediately upgradient of the site and a second piezometer will be located immediately downgradient of the site. Each piezometer will be drilled to the top of bedrock and screened in unconsolidated materials. If bedrock is encountered at shallow depths, the piezometers should be installed at least 10 ft below the water-table. In addition, if separate-phase contaminants with a density less than one are expected to be encountered at a site (e.g. petroleum USTs), the piezometers should be screened across the water-table such that free product thickness can be measured.

As soon as possible after piezometer installation and development, ground-water samples will be collected and analyzed for the contaminants detected in soils at the site. Each piezometer will be sampled at least twice; once to initially identify potential ground-water contaminants and a second time to confirm initial findings and help identify results which may be artifacts of the sampling or analysis process. A third sampling event also may be needed to resolve conflicting results. Because these sampling events are only directed at detecting ground-water contaminants, delays between sampling events needed to evaluate temporal fluctuations in contaminant concentrations will not be necessary. The ground-water sampling activities at each site can therefore be completed in a relatively short time frame.

Because piezometers will be constructed of PVC well casing and screens, sampling results may be considered qualitative or quantitative depending upon the types of contaminants present in the ground water. Qualitative data can be utilized to determine the presence of contaminants, but cannot be used to quantify their concentrations; quantitative data is suitable for both purposes. If high concentrations of VOCs are detected, the data for these constituents will be considered qualitative as PVC well construction may influence sample chemistry. Data for all other types of contaminants (e.g. metals) will be considered quantitative because PVC well materials are not expected to impact sample chemistry with respect to these constituents.

Assuming contamination is present, water-quality data obtained from the piezometers will be utilized to determine (1) if ground-water contamination at the site is the result of the migration of contaminants released from a source area located upgradient of the site, (2) if the site itself is a source of contamination, and (3) if the site has contributed to a contamination plume originating from other source areas. These determinations will be accomplished through comparing the types of contaminants present in the upgradient and downgradient piezometers with those detected in the soils at the site. If quantitative water-quality data are obtained from the well, a comparison of contaminant concentrations may also be performed.

If the analytical data for the soil and ground-water samples indicate that the site has not contributed contaminants to the ground-water system, further investigation of ground-water quality at the site will be terminated. However, if the data indicate that the site has released contaminants to the ground-water system, further investigation of ground-water quality will be included as part of the contamination assessment program for the UEFPC hydrogeologic regime described in the following section.

5.2.2 Exit Pathway Monitoring

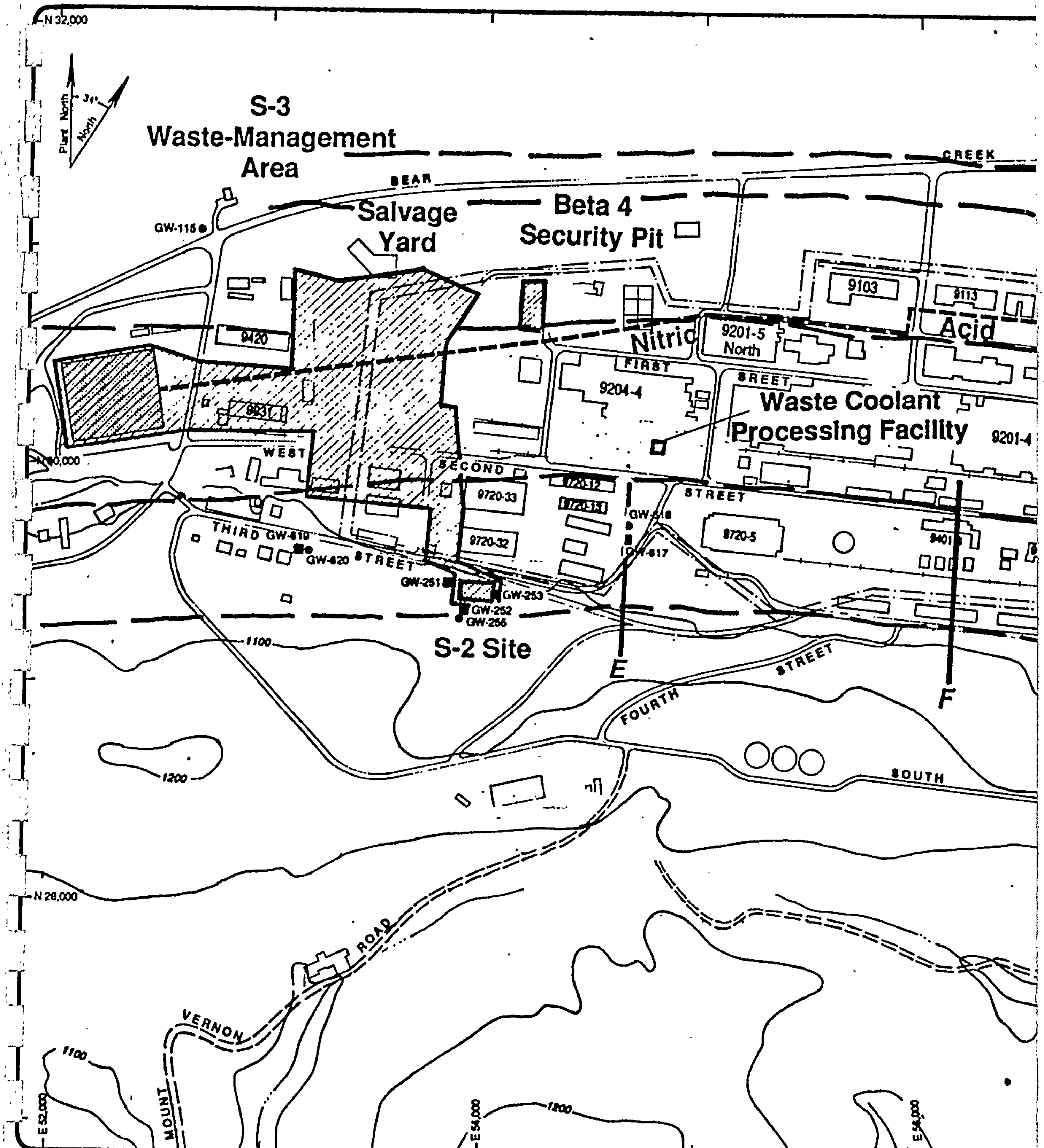
Exit pathway monitoring for the UEFPC hydrogeologic regime primarily involves ground water in the Maynardville Limestone which, as in the Bear Creek hydrogeologic regime, serves as the primary conduit for the migration of ground-water contaminants. The emphasis is on ground water because NPDES associated monitoring of surface water quality in UEFPC is extensive, and little additional surface water monitoring efforts are judged necessary.

5.2.3.1 Ground Water

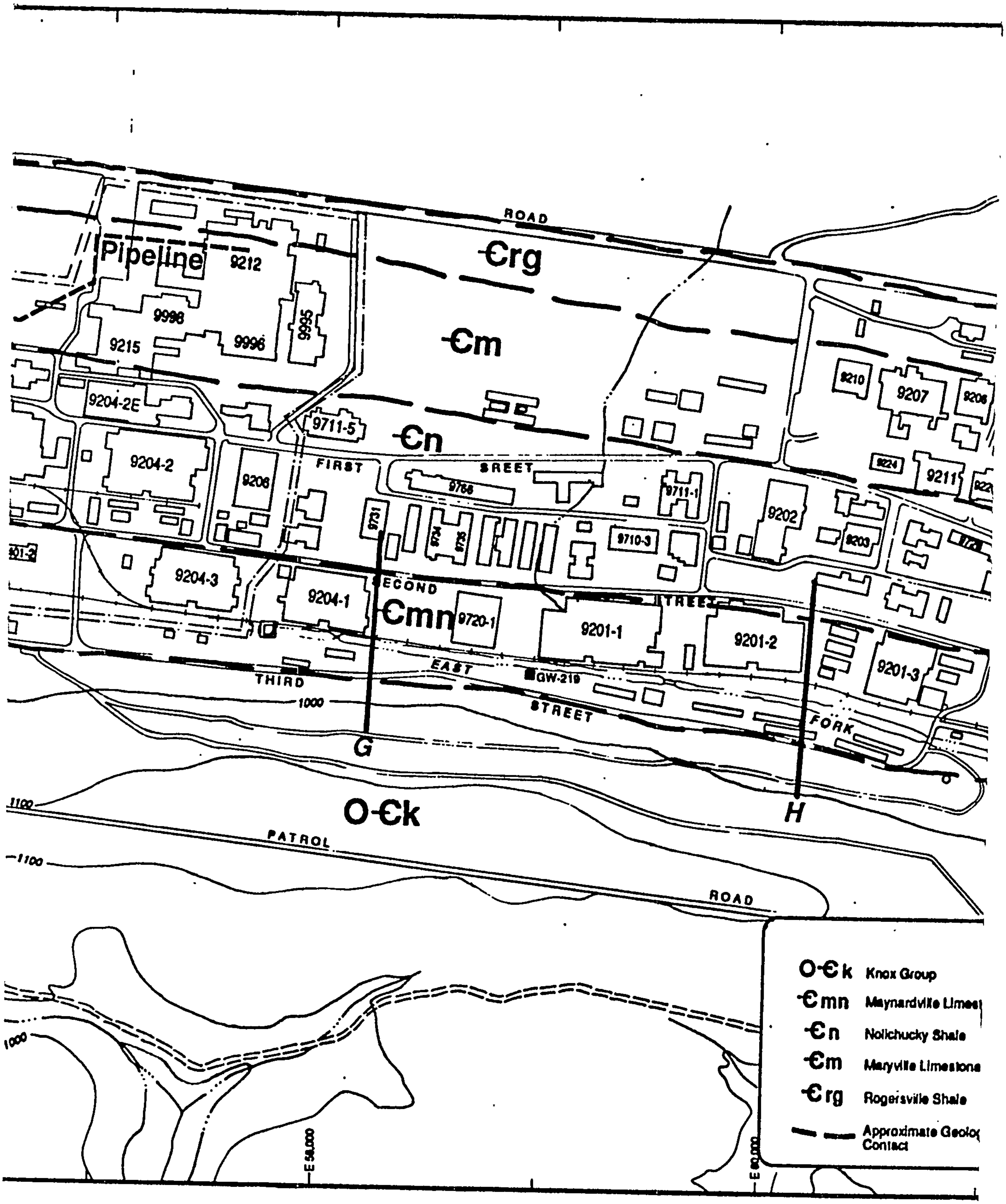
Exit pathway monitoring of ground water in the UEFPC hydrogeologic regime will be accomplished through the installation and subsequent sampling of monitor-well clusters along parallel traverses oriented perpendicular to the strike of the Maynardville and quarterly sampling of 36 existing wells. These wells and the proposed locations of the well-cluster traverses are shown on Figure 5-7. Five of the existing wells (GW-169, GW-170, GW-172, GW-230, and GW-232), not shown on Figure 5-7, monitor the Maynardville Limestone east of Scarboro Road in Union Valley.

As with the Bear Creek hydrogeologic regime, the specific well locations and target depths of the monitor-well clusters along perpendicular traverses to the Maynardville, will be based on a thorough evaluation of the existing data available for the Maynardville. Zones within the Maynardville that appear to be subject to solution cavity development will be delineated. Monitor wells will then be installed at each cluster location to monitor the down-dip extension of these stratigraphic zones as well as the shallow bedrock. Figure 5-3 illustrates the conceptual well placement of a well cluster traverse across strike of the Maynardville. In addition, the eastern most traverse includes a proposed core hole location (Figure 5-7). This core hole will be drilled through the entire thickness of the Maynardville Limestone and into the Nolichucky Shale to achieve stratigraphic overlap with existing core hole GW-129. Upon completion of drilling and geophysical logging, a multiple port monitoring system will be installed to monitor for lateral migration of contaminants at various depths.

Quarterly samples from the exit pathway wells will be analyzed for the standard suite of parameters identified on Table 5-2. In addition, selected wells along Scarboro



N 32,000
Plant North
34°
North
S-3
Waste-Management
Area
BEAR
CREEK
GW-115
Salvage
Yard
Beta 4
Security Pit
9103
9113
9420
9201-5
North
Nitric
Acid
FIRST
SREET
9204-4
9831
Waste Coolant
Processing Facility
9201-4
N 30,000
WEST
SECOND
STREET
9720-33
9720-12
9720-13
9720-32
9720-5
9401
THIRD
GW-619
GW-620
STREET
GW-618
GW-617
GW-251
GW-253
GW-252
GW-255
S-2 Site
1100
E
F
FOURTH
STREET
SOUTH
1200
N 28,000
ROAD
VERNON
MOUNT
1100
E 52,000
E 54,000
1200
E 56,000



ROAD
-Crg
-Cm
-Cn
-Cmn
O-Ck
Pipeline
9212
9998
9995
9215
9996
9204-2E
9711-5
9204-2
9206
FIRST
SREET
9766
9711-1
9210
9207
9224
9211
9202
9203
9731
9734
9735
9710-3
9204-3
9204-1
SECOND
STREET
9720-1
9201-1
9201-2
9201-3
THIRD
EAST
GW-219
STREET
FORK
1000
G
H
1100
PATROL
ROAD
E 58,000
E 60,000
Knox Group
Maynardville Limes
Nolichucky Shale
Maryville Limestone
Rogersville Shale
Approximate Geolo
Contact

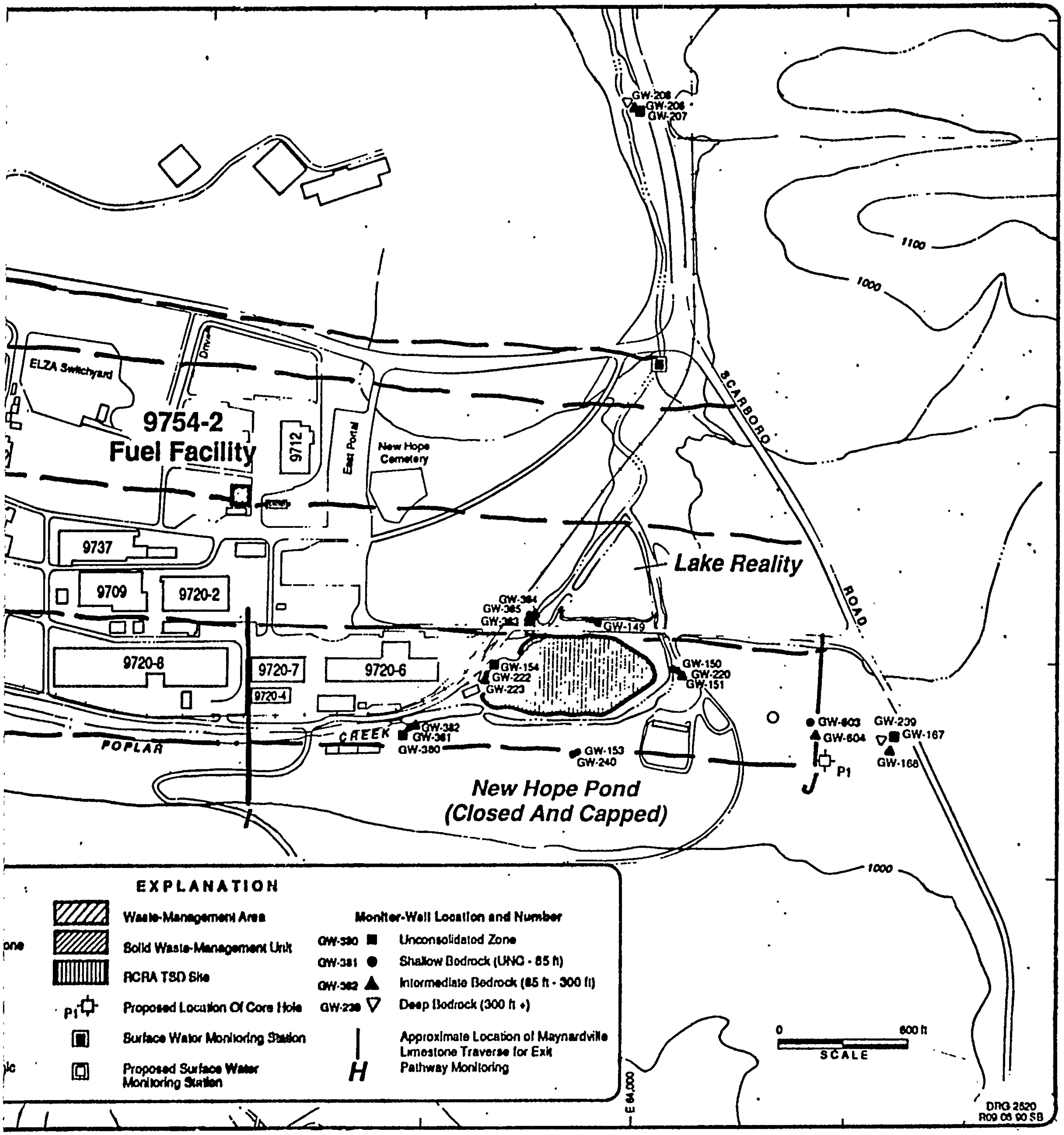


Figure 5-7. Monitor-Wells and Surface-Water Sampling Stations Included in the Exit-Pathway Monitoring Program for the Upper East Fork Poplar Creek Hydrogeologic Regime

Road and in Union Valley will include an analysis of isotopic uranium. As the contaminant source identification program progresses and additional data are available, the program may be modified to include other constituents (e.g. Base Neutral Extractable Organics or specific radionuclides). Sampling collection procedures and analytical methods are discussed in Sections 6.2 and 6.3, respectively.

5.2.2.2 Surface Water

Current efforts to monitor the quality of water discharged to and flowing in UEFPC are extensive. These efforts involve water-quality monitoring in accordance with NPDES requirements at 236 separate locations. Of these, 77 are classified as Category 1 NPDES outfalls, 83 are classified as Category 2 NPDES outfalls, and 84 are classified as Category 3 outfalls. The Category 1 and 2 NPDES outfalls represent storm water drainages and drainages from buildings with no associated process effluents. Only the Category 3 outfalls represent drainages from buildings and areas with associated process effluents containing radioactive and chemical liquid wastes (Peer Consultants P.C. 1988).

Until November 8, 1988, New Hope Pond served to regulate the flow and quality of water in UEFPC where it exited the Y-12 Plant to flow toward the City of Oak Ridge. Discharge from the pond averaged approximately 8 million gallons per day (mgd) and was monitored at an NPDES station located at the pond outfall. The pond has since been closed in accordance with RCRA standards and replaced by Lake Reality (Figure 5-7). Lake Reality is a lined surface impoundment covering approximately 2.5 acres.

Discharge from Lake Reality is monitored at Station 17 located near the intersection of UEFPC and Bear Creek Road (Figure 5-7). Monitoring at Station 17 is summarized on Table 5-7. As part of the monitoring efforts at Station 17, grab samples are collected two times a day for mercury analysis, 24-hour composite samples are collected weekly

Table 5-7. Monitored Parameters at Station 17, Upper East Fork Poplar Creek

Sampled Twice Daily Five Days/Week

Mercury

24-hour Composite Sample/ Weekly

Composite

Alkalinity Carbonate
Alkalinity Bicarbonate
Chloride
Fluoride
Nitrate (as N)
Phosphorus
Sulfate
total Suspended Solids
Total Dissolved Solids
Total Organic Carbon
Cadmium (AAS)
Lead (AAS)
Nickel (AAS)
Selenium (AAS)
ICP Metals Scan
Mercury

Two Grab Samples

Total Residual Chloride
Volatile Organic Compounds (EPA Method 624)

Seven Day Composite Sample/ Week

Radionuclide Analyses

5SEP90 Ba

and 7-day composite samples are collected weekly for radionuclide analyses (Personal Communication, W. McMahon, August 29, 1989).

The above described monitoring efforts far exceed what is needed for exit pathway monitoring of surface water quality in UEFPC. For exit-pathway monitoring purposes, surface water quality monitoring will be conducted only at two locations; one where UEFPC emerges from the Y-12 Plant storm-sewer drainage system about 1 mile west of New Hope Pond, and Station 17 (Figure 5-7). The first sampling location represents the farthest upstream point at which potential receptors may be exposed to contaminants in UEFPC and will therefore provide data needed for risk-assessment studies. Surface water samples will be collected from this sampling point quarterly and analyzed for the standard suite of parameters (Table 5-2) and isotopic uranium. Continued surface-water monitoring at Station 17 will ensure that the quality of water leaving the Y-12 Plant via UEFPC is adequately monitored. Other constituents may also be included (e.g. Base Neutral Extractable Organics) as additional data are available to warrant their inclusion.

5.2.3 Contaminant Plume Assessment

To effectively evaluate the extent of ground-water contamination throughout the UEFPC hydrogeologic regime, an investigative approach consisting of three phases will be implemented: Phase I directed at delineating the overall horizontal extent of ground-water contamination in the unconsolidated and shallow bedrock aquifer zones, and identifying all hazardous constituents in the plumes; Phase II directed at delineating the overall vertical extent of ground-water contamination in a deeper bedrock aquifer zone and the occurrence of DNAPLs at selected likely source areas; and Phase III involving a more refined delineation of the perimeter of the contaminant plumes (if needed) by installing additional wells between clean and contaminated well-clusters within each zone.

Phase I involves delineation of the horizontal extent of ground-water contamination through the installation of monitor wells in a rectangular grid pattern that is consistent with the ground-water flow anisotropy. The first step in implementing Phase I will involve an evaluation of methods and procedures (e.g. Hydropunch^{TM}) which may be used to screen the shallow ground waters for contamination. The screening approach is intended to reduce the number of unconsolidated wells at every grid point. Using this grid pattern, wells are more widely spaced parallel with strike because this is a more permeable flow path, and more closely spaced across strike where flow is more restricted. This configuration is appropriate because aquifer pumping tests have resulted in elliptical cones of drawdown elongate along strike. Thus, if recovery wells are needed, the assumed horizontal well distribution would be similar, although probably less dense, than that of the monitor wells once Phase III is completed.

This approach has several advantages. First, it will significantly reduce the total number of wells needed to assess the extent of ground-water contamination from that which would be needed if a site-by-site approach were employed. Second, it will provide the maximum areal coverage of the UEFPC hydrogeologic regime with the minimum number of wells. Third, it provides the most efficient means of determining the three-dimensional extent of ground-water contamination. Finally, this approach will enable more effective planning and allocation of available resources since the total number of wells to be installed will be known from the outset of each phase of the investigation.

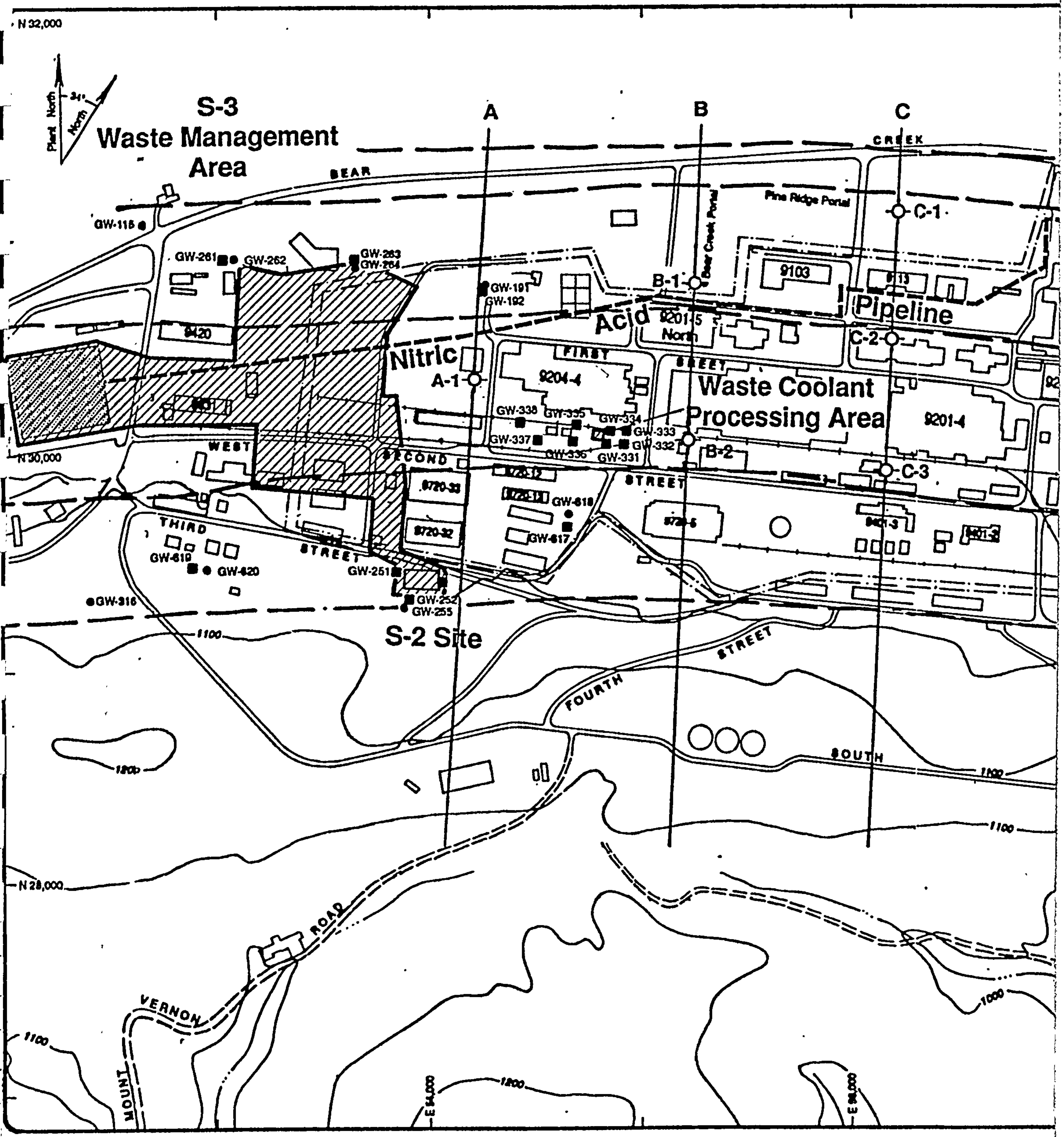
5.2.3.1 Phase I. Horizontal Plume Delineation

As noted above, the first phase of the proposed ground-water contamination assessment program is intended to establish the overall horizontal extent of ground-water contamination in the UEFPC hydrogeologic regime in the unconsolidated and shallow bedrock aquifer zones, and to identify all hazardous constituents present in the contaminant plumes. Details regarding the proposed monitor-well network, monitored parameters and constituents, sampling frequency, and an estimated schedule for implementation of these activities are provided in the following sections.

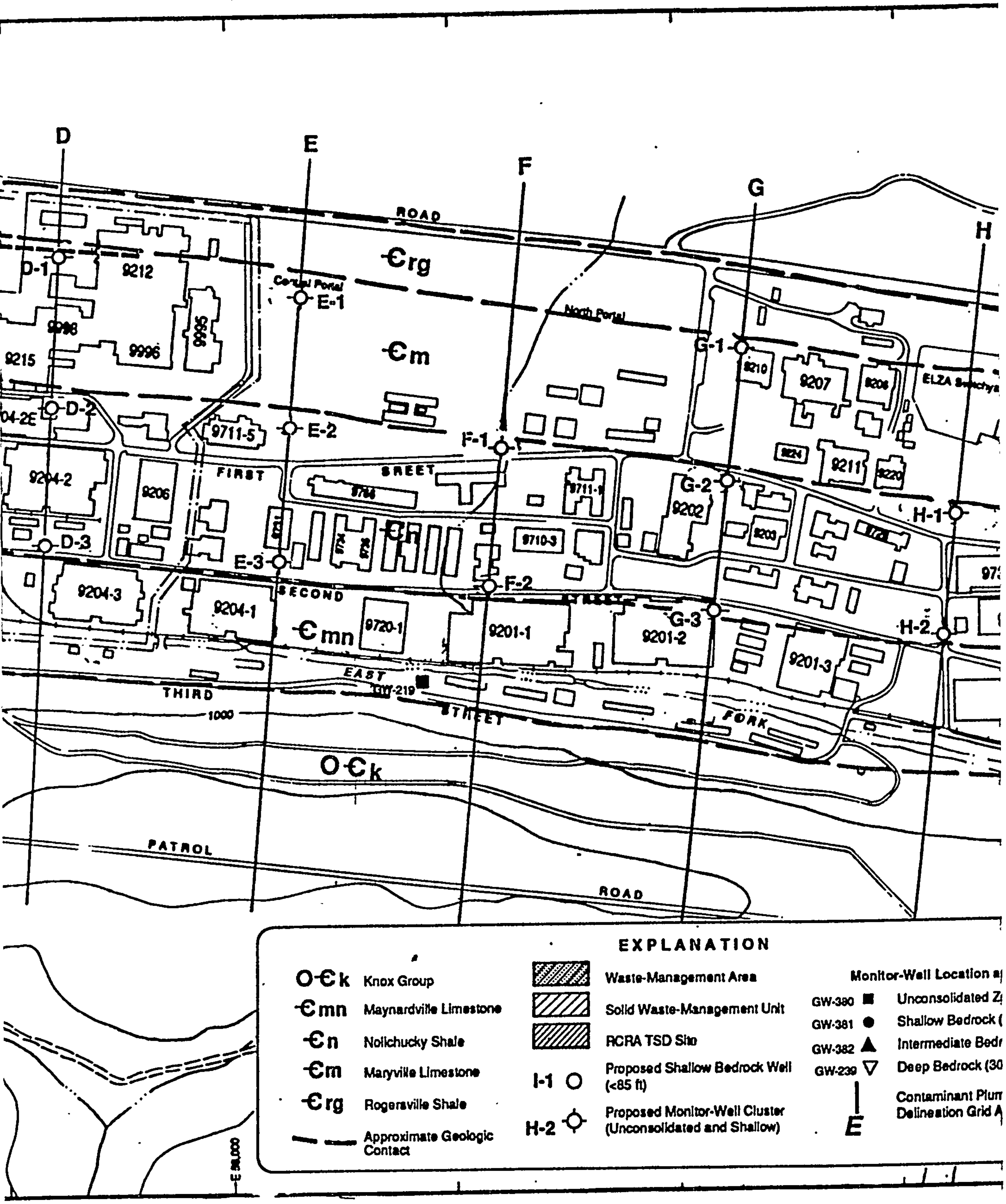
5.2.3.1.1 Monitor-Well Network

The Phase I monitor well grid pattern for the UEFPC hydrogeologic regime is shown on Figure 5-8. As shown, the grid consists of 11 vertical (north-south) axes, designated A through K. Horizontal (east-west) axes are represented by the contacts between geologic formations. As shown on Figure 5-8, the grid begins just east of the S-3 WMA and extends to Scarboro Road; the extent of ground-water contamination in the S-3 area has been well defined (Geraghty & Miller, Inc. 1990c and 1990d). The grid axes are spaced about 1000 ft apart in the east-west (strike) direction and approximately 500 ft apart in north-south (dip) direction. In most cases, each location represents a two-well cluster consisting of an unconsolidated well and a shallow (less than 85 ft) bedrock well. The installation of monitor wells in the Maynardville Limestone are excluded from the grid approach. Monitoring of the Maynardville is addressed in the exit pathway monitoring system; however, wells in the exit pathway will also be used in the contaminant plume assessment.

Efforts are currently underway to evaluate methods for screening shallow ground water for contamination. One such option under consideration is the use of Hydropunch™; hydraulically driven into unconsolidated materials, the Hydropunch™ provides a mechanism for the collection of water samples. The presence of cobbly fill materials however may limit its use. The use of a screened auger is also being considered. The evaluation of temporary ground-water sampling technologies is intended to provide a means of determining the presence or absence of contamination in the shallow ground water and eliminate the need for an unconsolidated well at each grid point. Thus, the first



N 32,000
Plant North
34°
North
S-3
Waste Management
Area
BEAR
CREEK
A
B
C
Pine Ridge Portal
Bear Creek Portal
C-1
GW-115
GW-261
GW-262
GW-263
GW-264
GW-191
GW-192
B-1
9103
9113
Pipeline
Acid
9201-5
North
9420
C-2
Nitric
FIRST
STREET
9204-4
A-1
Waste Coolant
Processing Area
9201-4
GW-338
GW-335
GW-334
GW-333
GW-332
GW-331
GW-336
GW-337
B-2
C-3
WEST
SECOND
STREET
N 30,000
9720-33
9720-12
GW-618
GW-617
9720-32
9720-5
9401-3
9401-2
THIRD
STREET
GW-619
GW-620
GW-251
GW-252
GW-255
GW-316
S-2 Site
1100
FOURTH
STREET
SOUTH
1200
N 28,000
ROAD
VERNON
MOUNT
1000
E 54,000
E 56,000



D
E
F
G
H
ROAD
Єrg
Central Portal
E-1
North Portal
D-1
9212
9998
9996
9215
Єm
G-1
9210
9207
ELZA
D-2
E-2
9711-5
F-1
FIRST
SREET
9204-2
9206
G-2
9202
9211
9220
H-1
D-3
9710-3
E-3
F-2
9204-3
9204-1
SECOND
STREET
G-3
9201-1
9201-2
H-2
9720-1
Єmn
9201-3
EAST
THIRD
GW-219
1000
STREET
FORK
O-Єk
PATROL
ROAD
EXPLANATION
O-Єk Knox Group
Єmn Maynardville Limestone
Єn Nolichucky Shale
Єm Maryville Limestone
Єrg Rogersville Shale
Approximate Geologic Contact
Waste-Management Area
Solid Waste-Management Unit
RCRA TSD Site
I-1 Proposed Shallow Bedrock Well (<85 ft)
H-2 Proposed Monitor-Well Cluster (Unconsolidated and Shallow)
Monitor-Well Location a
GW-380 Unconsolidated Z
GW-381 Shallow Bedrock (
GW-382 Intermediate Bedr
GW-239 Deep Bedrock (30
E
Contaminant Plum
Delineation Grid A

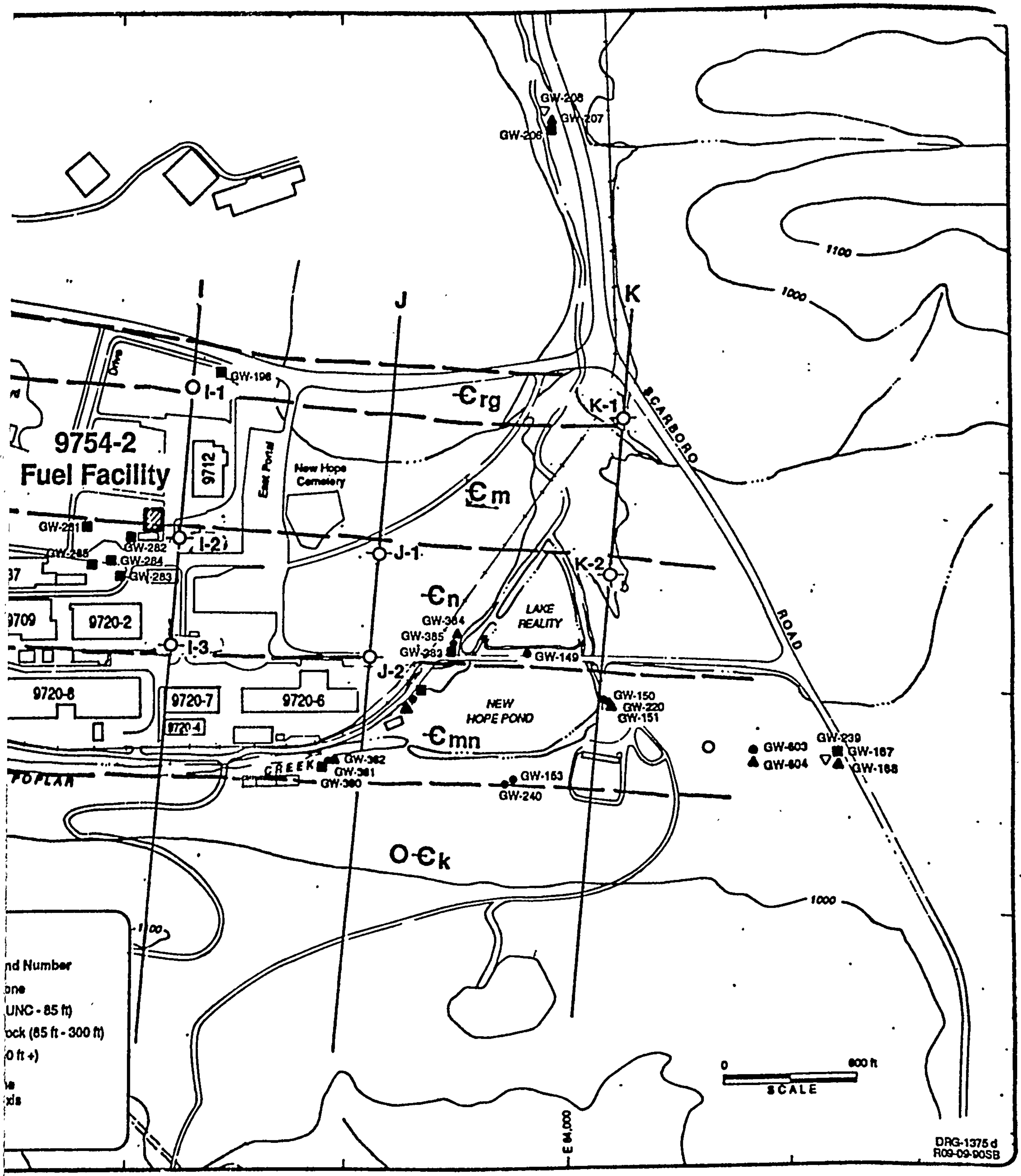


Figure 5-8. Proposed Phase I Monitor-Well Network for the Ground-Water Contamination Assessment Program in the Upper East Fork Poplar Creek Hydrogeologic Regime

step in Phase I will be a review of possible methods for screening shallow ground water for contamination.

Assuming a method of screening the shallow ground water for contamination is not employed, the proposed Phase I monitor-well network will initially consist of a total of 109 wells, 58 of which are existing wells. Information regarding the existing and proposed well depths, monitored formations and monitored intervals is summarized on Table 5-8. Thirty-one of the existing wells are incorporated into the exit pathway monitoring system for the UEFPC hydrogeologic regime. As shown on Table 5-8, 13 of the existing wells are unconsolidated wells centered around two specific sites, the Waste Coolant Area and the 9754-2 Fuel Facility. Once sufficient data are obtained to adequately characterize the shallow ground-water quality at these sites, continued sampling of all of these wells will not be necessary. Due to the lack of monitor-well coverage in the UEFPC hydrogeologic regime, the installation of 51 new wells (25 unconsolidated wells and 26 shallow bedrock wells) are proposed. Methods for monitor-well installation and construction are discussed in Section 6.1.3.

The proposed unconsolidated zone wells are to be drilled to the top of rock (about 30 ft below grade). It is recognized that the effectiveness of these wells for contamination assessment purposes may be influenced by the re-worked land surface in the UEFPC hydrogeologic regime associated with construction of the Y-12 Plant. In particular, utility line excavations and subsurface drains which extend below the water table may function as permeable conduits for ground-water flow that are unrelated to the hydrologic characteristics of the surrounding "undisturbed" materials. Nonetheless, the unconsolidated wells will provide important hydrologic and water-quality information, and may be especially useful in evaluating the effects of underground utilities and other man-made features on ground-water flow in UEFPC hydrogeologic regime.

Table 5-8. Existing and Proposed Wells Included in the Monitor-Well Network for the Upper East Fork Poplar Creek Hydrogeologic Regime

Profile	Well No.	Monitored Interval (ft)	Screen/Open	Formation Monitored	
S-3 Area	GW-115	42.0 -52.0	Screen	BDR	Ꞓm
	GW-261	16.7 - 32.7	Screen	UNC	—
	GW-262	57.7 - 70.6	Screen	BDR	Ꞓn
	GW-263	25.5 - 30.8	Screen	UNC	—
	GW-264	60.5 - 70.7	Screen	BDR	Ꞓm
Waste Coolant Area	GW-331	23.0 - 30.1	Screen	UNC	—
	GW-332	16.8 - 24.1	Screen	UNC	—
	GW-333	13.7 - 25.0	Screen	UNC	—
	GW-334	19.8 - 27.2	Screen	UNC	—
	GW-335	7.6 - 15.7	Screen	UNC	—
	GW-336	13.2 - 21.4	Screen	UNC	—
	GW-337	15.0 - 22.1	Screen	UNC	—
	GW-338	11.2 - 17.6	Screen	UNC	—
A	GW-191	49.5 - 59.5	Screen	BDR	Ꞓm
	GW-192	7.5 - 17.5	Screen	UNC	—
	A1a	20 - 30*		UNC	—
	A1b	45 - 80*		BDR	Ꞓn
B	B1a	20 - 30*		UNC	—
	B1b	45 - 80*		BDR	Ꞓm
	B2a	20 - 30*		UNC	—
	B2b	45 - 80*		BDR	Ꞓn
C	C1a	20 - 30*		UNC	—
	C1b	45 - 80*		BDR	Ꞓm
	C2a	20 - 30*		UNC	—
	C2b	45 - 80*		BDR	Ꞓm
	C3a	20 - 30*		UNC	—
	C3b	45 - 80*		BDR	Ꞓn
D	D1a	20 - 30*		UNC	—
	D1b	45 - 80*		BDR	Ꞓm
	D2a	20 - 30*		UNC	—
	D2b	45 - 80*		BDR	Ꞓn
	D3a	20 - 30*		UNC	—
	D3b	45 - 80*		BDR	Ꞓn
E	E1a	20 - 30*		UNC	—
	E1b	45 - 80*		BDR	Ꞓm
	E2a	20 - 30*		UNC	—
	E2b	45 - 80*		BDR	Ꞓn
	E3a	20 - 30*		UNC	—
	E3b	45 - 80*		BDR	Ꞓn
F	F1a	20 - 30*		UNC	—
	F1b	45 - 80*		BDR	Ꞓn
	F2a	20 - 30*		UNC	—
	F2b	45 - 80*		BDR	Ꞓn
G	G1a	20 - 30*		UNC	—
	G1b	45 - 80*		BDR	Ꞓm
	G2a	20 - 30*		UNC	—
	G2b	45 - 80*		BDR	Ꞓn
	G3a	20 - 30*		UNC	—
	G3b	45 - 80*		BDR	Ꞓn
H	H1a	20 - 30*		UNC	—
	H1b	45 - 80*		BDR	Ꞓn
	H2a	20 - 30*		UNC	—
	H2b	45 - 80*		BDR	Ꞓn
I	GW-198	16.5 - 26.5	Screen	UNC	—
	I1	45 - 80*		BDR	Ꞓrg
	I2a	20 - 30*		UNC	—
	I2b	45 - 80*		BDR	Ꞓn
	I3a	20 - 30*		UNC	—
	I3b	45 - 80*		BDR	Ꞓn

11SEPT90 Ba

BDR = Bedrock UNC = Unconsolidated Zone

* = For proposed unconsolidated wells, monitor interval is to top of rock
For proposed shallow bedrock wells, target water-bearing zones within 45 to 80 ft interval

Table 5-8. Continued...

Profile	Well No.	Monitored Interval (ft)	Screen/Open	Formation Monitored	
9754-2 Fuel Facility	GW-281	5.0 - 15.0	Screen	UNC	—
	GW-282	4.0 - 14.0	Screen	UNC	—
	GW-283	4.0 - 20.0	Screen	UNC	—
	GW-284	N/A	Screen	UNC	—
	GW-285	3.5 - 21.0	Screen	UNC	—
J	J1a	20 - 30*		UNC	—
	J1b	45 - 80*		BDR	Ꞓn
	J2a	20 - 30*		UNC	—
	J2b	45 - 80*		BDR	Ꞓn
K	K1a	20 - 30*		UNC	—
	K1b	45 - 80*		BDR	Ꞓrg
	K2a	20 - 30*		UNC	—
	K2b	45 - 80*		BDR	Ꞓn
	GW-149	36.0 - 50.5	Screen	BDR	Ꞓn
Maynardville (exit pathway)	GW-150	6.2 - 11.2	Screen	BDR	Ꞓmn
	GW-151	86.0 - 96.0	Screen	BDR	Ꞓmn
	GW-153	45.0 - 60.0	Screen	BDR	Ꞓmn
	GW-154	4.7 - 11.2	Screen	UNC	—
	GW-219	5.7 - 11.3	Screen	UNC	—
	GW-220	34.7 - 44.7	Screen	BDR	Ꞓmn
	GW-222	18.0 - 25.0	Screen	BDR	Ꞓmn
	GW-223	79.5 - 90.5	Screen	BDR	Ꞓmn
	GW-240	21.0 - 29.5	Screen	BDR	Ꞓmn
	GW-251	35.0 - 51.0	Screen	BDR	Ꞓmn
	GW-252	43.8 - 48.8	Screen	UNC	—
	GW-253	36.2 - 50.0	Screen	BDR	Ꞓmn
	GW-255	71.3 - 81.3	Screen	BDR	Ꞓmn
	GW-380	9.8 - 15.2	Screen	UNC	—
	GW-381	49.3 - 60.4	Open	BDR	Ꞓmn
	GW-382	125.0 - 175.0	Open	BDR	Ꞓmn
	GW-383	16.6 - 23.6	Screen	UNC	—
	GW-384	35.5 - 55.7	Open	BDR	Ꞓn
	GW-385	123.7 - 178.7	Open	BDR	Ꞓn
	GW-617	6.8 - 18.0	Screen	UNC	—
	GW-618	26.0 - 37.0	Screen	BDR	Ꞓmn
	GW-619	26.8 - 40.8	Screen	UNC	—
	GW-620	61.7 - 75.0	Screen	BDR	Ꞓmn
	GW-603	63.4 - 75.2	Screen	BDR	Ꞓmn
	GW-604	100.0 - 112.4	Screen	BDR	Ꞓmn
	GW-239	404.0 - 433.3	Open	BDR	Ꞓn
	GW-167	25.0 - 30.1	Screen	UNC	—
	GW-168	104.0 - 135.4	Open	BDR	Ꞓn
	GW-206	10.0 - 16.9	Screen	UNC	—
	GW-207	100.0 - 109.6	Open	BDR	Ꞓr
	GW-208	404.0 - 412.8	Open	BDR	Ꞓr
	GW-169	28.7 - 34.7	Screen	UNC	—
	GW-170	104.0 - 156.9	Open	BDR	Ꞓmn
	GW-172	105.0 - 133.8	Open	BDR	Ꞓmn
	GW-230	341.0 - 406.4	Open	BDR	Ꞓmn
	GW-232	401.1 - 411.7	Open	BDR	Ꞓmn

11SEPT90 8a   BDR = Bedrock   UNC = Unconsolidated Zone

* = For proposed unconsolidated wells, monitor interval is to top of rock
For proposed shallow bedrock wells, target water-bearing zones within 45 to 80 ft interval

As shown on Figure 5-8 and Table 5-8, shallow bedrock wells located more than approximately 500 ft north of UEFPC will monitor either the Nolichucky Shale, the Maryville Limestone, or the Rogersville Shale and wells in close proximity to UEFPC will monitor the Maynardville Limestone. Shallow bedrock wells in each proposed well cluster will be drilled to target water-bearing zones within a 45 to 80 ft depth interval.

The primary concern is protection of human health and the environment and since the most sensitive receptors are associated with East Fork Poplar Creek and the City of Oak Ridge, well installation activities will proceed from east (near the exit pathway) to west and from south (in the Maynardville Limestone) to north. The shallow bedrock well of each well cluster will be installed first. This will reduce disturbance and possible grouting of the paired well during installation.

5.2.3.1.2 Monitored Parameters

During Phase I of the contamination assessment program in the UEFPC, ground-water samples will be analyzed for the standard suite of constituents (Table 5-2). In addition, as outlined in the 1989 GWQAR for the UEFPC hydrogeologic regime, selected existing wells will be analyzed for specific radionuclides. Unconsolidated wells monitoring ground water near the Fuel Facility site will include an analysis of total petroleum hydrocarbons (TPH). As with the contamination assessment program proposed for the Bear Creek hydrogeologic regime, utilization of a standard suite of contamination assessment parameters will work to simplify the organization, management, and implementation of the monitoring activities. Moreover, it will enable a more accurate estimation of the total analytical costs associated with this phase of the investigation.

Since all the new and proposed Phase I wells are or will be constructed with stainless steel well casing and screens, data obtained from these wells will be considered quantitative. Sample collection procedures and analytical methods are discussed in Sections 6.2 and 6.3, respectively.

5.2.3.1.3 Monitoring Frequency

Ground-water samples will be collected quarterly for one year from all the Phase I wells. This sampling frequency complies with applicable regulations governing ground-water contamination assessment and is needed to evaluate temporal changes in water quality. In addition, quarterly sampling will generate the data needed for the data interpretation procedure described in Section 6.5. To expedite the Phase I investigation, new wells should be sampled as soon as possible after their development.

5.2.3.1.4 Hazardous Constituent Identification

After all the Phase I wells have been sampled quarterly for one year, and an evaluation of the analytical results is completed, ground-water samples will be collected from selected wells and analyzed for the hazardous constituents listed in Appendix IX to 40 CFR Part 264. The purpose of these analyses will be to identify all hazardous constituents and their maximum concentrations (excluding statistical outliers) in the contaminant plumes in the UEFPC hydrogeologic regime.

Several factors will be evaluated in selecting wells for Appendix IX sampling. These include the degree of contamination in the well, the proximity of the wells to contaminant source areas, surrounding ground-water quality conditions, and the location of the wells with respect to the exit pathways of the ground-water system. This selection process will work to ensure that wells with the largest variety of contaminants and the highest contaminant concentrations are sampled such that all hazardous constituents are identified and the need for future Appendix IX analyses is avoided.

Results of these analyses, along with the quarterly sampling results, will then be processed through the data-validation procedure described in Section 6.5. This procedure will be used to identify those hazardous constituents that are present in the contaminant plumes at concentrations which may pose a threat to human health and the environment. Risk assessment studies can then be focused on these contaminants.

5.2.3.1.5 Implementation Schedule

Based upon past experience with ground-water investigations at the Y-12 Plant, it is estimated that the above described Phase I drilling and sampling activities can be accomplished in about 46 weeks (Figure 5-9) following notification of approval for drilling activities under the National Environmental Policy Act (NEPA). This time frame is based upon the following assumptions: (1) the use of two air rotary type drilling rigs for bedrock wells and one auger rig for unconsolidated wells, (2) the installation of two unconsolidated zone wells every 3 working days, (3) the installation of two bedrock wells every three working days (one well per drilling rig), (4) minimum delays associated with the containment of water, soil, and rock removed from the boreholes, (5) utilization of a separate well development/completion crew, (6) development of 4 wells per working week, (7) the sampling of new wells within one week after their development, and (8) sampling of 20 wells per working week during subsequent quarterly sampling events.

There may be a significant time-delay, due to the NEPA requirements, before the Phase I contamination assessment program can be implemented. Until that time, Energy Systems should continue site specific monitoring efforts, such as contamination assessment monitoring at New Hope Pond. However, future expansion of these site-specific monitoring programs, particularly the installation of new monitoring wells, will be designed and implemented in the context of the overall contamination assessment program for the UEFPC hydrogeologic regime.

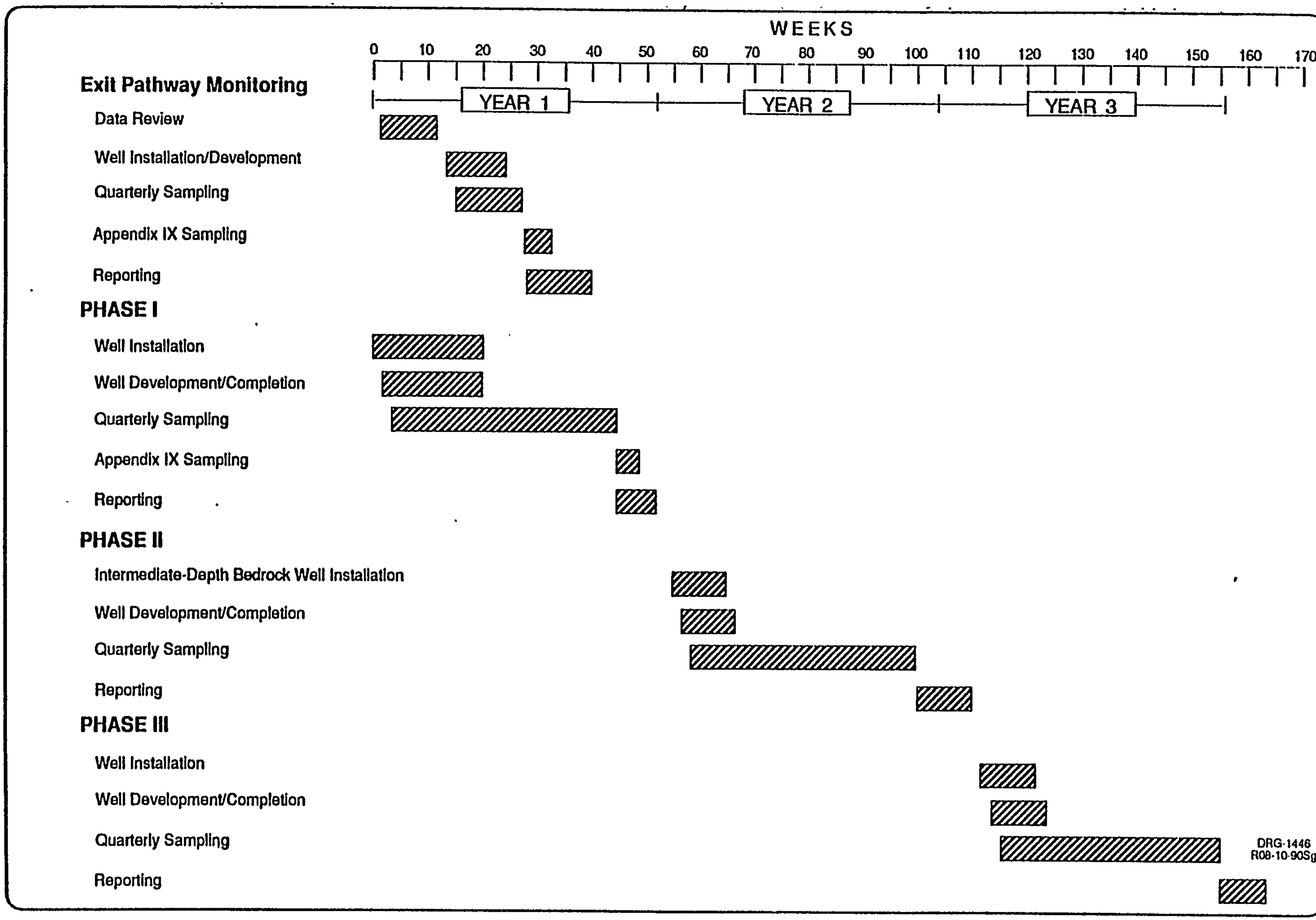


Figure 5-9. Proposed Schedule for Completion of the Ground-Water Contamination Assessment Program for the Upper East Fork Poplar Creek Hydrogeologic Regime

5.2.3.2 Phase II. Vertical Plume Delineation

Phase II of the proposed ground-water contamination assessment program for UEFPC hydrogeologic regime will involve the vertical delineation of ground-water contamination. Specific investigative details for Phase II, however, will be determined after a complete evaluation of the data obtained during Phase I.

5.2.3.2.1 Intermediate-Depth Bedrock Well Network

To determine the overall vertical extent of ground-water contamination in the UEFPC hydrogeologic regime, a deeper bedrock well will be installed at each new and existing Phase I well-cluster with contaminated ground-water in the shallow bedrock (<85 ft) well. The intermediate-depth bedrock wells will not exceed a total depth of 300 ft. This depth is based upon permeability data obtained from wells located throughout the Bear Creek hydrogeologic regime. Review of these data suggest that the "floor" of the most active portion of the ground-water system is approximately between 200 and 500 ft below grade. Although there is undoubtedly some ground-water flow at greater depths, the permeability data indicate the flow rate is generally very slow and consequently may not play a significant role in contaminant transport. Since the ultimate objective of the investigation is to determine the extent and rate of contaminant migration, the contamination assessment program should be focused where a significant degree of contaminant transport is most likely to occur.

Each intermediate-depth well will be an open interval monitor well which is cased off from the surface to about 250 ft. The length of the open interval, not to exceed 50 ft, will be determined based upon fractured zones encountered during drilling. If a fracture zone is encountered while drilling the open interval it may be necessary to allow the well to sit overnight to ensure an adequate yield. Although a discrete (10 ft) monitor interval is preferred, particularly if DNAPLs are suspected, the low yields and fractured nature of the

Conasauga Group stratigraphy generally precludes small monitor intervals at these depths. Prior to installation of the intermediate-depth well, geologic logs of the unconsolidated and shallow bedrock well cluster will be reviewed to identify fracture zones which may be affected by installation of the intermediate-depth well. It may be necessary to off-set the intermediate-depth well location to minimize disturbance to the existing well-cluster. If at any point during drilling DNAPL is encountered, drilling will immediately be discontinued at that location.

5.2.3.2.2 Monitored Parameters

During Phase II of the contamination assessment program in the UEFPC, ground-water samples collected from these wells will be analyzed for the standard suite if parameters (Table 5-2). Other constituents may also be included (e.g. Base Neutral Extractable Organics) depending upon the results of the Appendix IX sampling conducted during Phase I. Sample collection procedures and analytical methods are discussed in Sections 6.2 and 6.3, respectively.

5.2.3.2.3 Monitoring Frequency

Ground-water samples from the bedrock wells installed during Phase II will be collected quarterly for one year. The rationale for this sampling frequency is the same as that stated for the Phase I wells. To expedite the Phase II investigation, wells should be sampled as soon as possible after their development.

5.2.3.2.4 Implementation Schedule

The primary factor influencing the implementation of Phase II investigation will be the number of intermediate-depth wells to be installed. This determination cannot be made until the Phase I investigation is complete. However, assuming that these wells will not have to be installed at each Phase I well-cluster location and that two air-rotary type drilling rigs will concurrently install the Phase II wells, it is estimated that Phase II of the ground-water contamination assessment program for the UEFPC hydrogeologic regime will take about 50 weeks to complete (Figure 5-9).

5.2.3.2.5 Dense Nonaqueous Phase Liquids

Sites at the Y-12 Plant, such as the Waste Coolant Area and the Salvage Yard Area, where organics were handled in appreciable amounts, are possible source areas for the occurrence of DNAPLs. Investigations into the presence or absence of DNAPLs in the UEFPC hydrogeologic regime will be focused on these likely source areas. Contamination assessment of DNAPLs at the Y-12 Plant is complicated by several factors: (1) due to the fractured nature of the underlying Conasauga Group formations, the migration and occurrence of DNAPLs are likely to be very sporadic, (2) due to interfacial tension forces an increase in capillary pressure can allow DNAPLs to migrate into smaller and smaller aperture fractures and residual DNAPL pools can be left behind along the migration pathway, (3) drilling or pumping a well will increase capillary pressures and can remobilize a DNAPL pool, possibly into previously uninvaded fractures, worsening the extent of contamination, and (4) dissolved concentrations in ground water, even relatively close to the DNAPL source, can range from near the solubility to orders of magnitude less than the aqueous solubility of the DNAPL components.

In light of these factors and to minimize the risk of DNAPL remobilization, the strategy to investigate DNAPL occurrence will be to monitor from the outside inward. The approach to this investigation is to acquire water-quality data, hydraulic gradient data, and geologic samples which can be used to infer the presence or absence of DNAPLs. Drilling to depths greater than about 300 ft will be minimized and conducted well beyond the downgradient/downdip extent of potential DNAPL source areas. Data can be obtained by drilling either a core hole and using packers to monitor discrete intervals or installation of a deep monitor well cluster. Headspace analysis of geologic samples; geochemical analysis of a dissolved plume, including detailed profiles of dissolved contaminant concentrations and concentration ratios (assuming multi-component DNAPL); and an analysis of contaminant concentrations in zones with upward vertical gradients can be evaluated to infer DNAPL presence or absense.

Because of the unique problems associated with a DNAPL investigation and the lack of "tried and true" DNAPL investigative techniques, it is premature to develop the details of a DNAPL monitoring program. These investigations may be better developed within the framework of smaller scale separate studies; although the results of any DNAPL investigations would be reported in the UEFPC hydrogeologic regime annual GWQAR.

5.2.3.3 Phase III. Final Plume Assessment

Phase III of the proposed ground-water contamination assessment program for the UEFPC hydrogeologic regime is directed at completing the horizontal and vertical contaminant plume delineation. Details regarding the proposed monitor-well network, monitored parameters and constituents, sampling frequency, and an estimated schedule for implementation of these activities are provided in the following sections.

5.2.3.3.1 Monitor-Well Network

Additional monitor wells may be installed to complete the horizontal delineation of of ground-water contamination within each of the vertical aquifer zones. To accomplish this goal, the Phase III monitor wells will be located halfway between non-contaminated well clusters and contaminated well clusters. This approach to the location of the Phase III wells is based upon two fundamental assumptions: (1) ground-water contamination is continuous between contaminated well clusters, and (2) ground water between non-contaminated well clusters is clean. Accordingly, no Phase III wells will be installed between well clusters that are either both contaminated or both non-contaminated.

As illustrated on Figure 5-10, the approach to the location of the Phase III wells will result in a final grid resolution of roughly 500 ft (east-west) by 250 ft (north-south) within each aquifer zone. This will include the installation of individual unconsolidated zone wells, shallow bedrock (<85 ft) wells, and intermediate-depth bedrock wells (<300 ft). The type of well installed at each Phase III location will be determined by the water-quality conditions observed in adjacent wells at similar depths. For example, a Phase III unconsolidated zone well will be installed halfway between a well cluster with a clean unconsolidated zone well and a well cluster with a contaminated unconsolidated zone well. Likewise for the shallow and intermediate-depth bedrock wells. Thus, individual wells of each type, or well clusters consisting of various combinations of the three well types, may be installed at any given Phase III location.

5.2.3.3.2 Monitored Parameters

Ground-water samples collected from the Phase III monitor wells will be analyzed for the standard suite of constituents (Table 5-2). Other constituents may also be included (e.g. Base Neutral Extractable Organics) depending upon the results of the Appendix IX sampling conducted during Phase I. Sample collection procedures and analytical methods are discussed in Sections 6.2 and 6.3, respectively.

5.2.3.3.3 Monitoring Frequency

Ground-water samples from the wells installed during Phase III will be collected quarterly for one year. The rationale for this sampling frequency is the same as that stated for the Phase I and II wells. To expedite the Phase III investigation, wells should be sampled as soon as possible after their development.

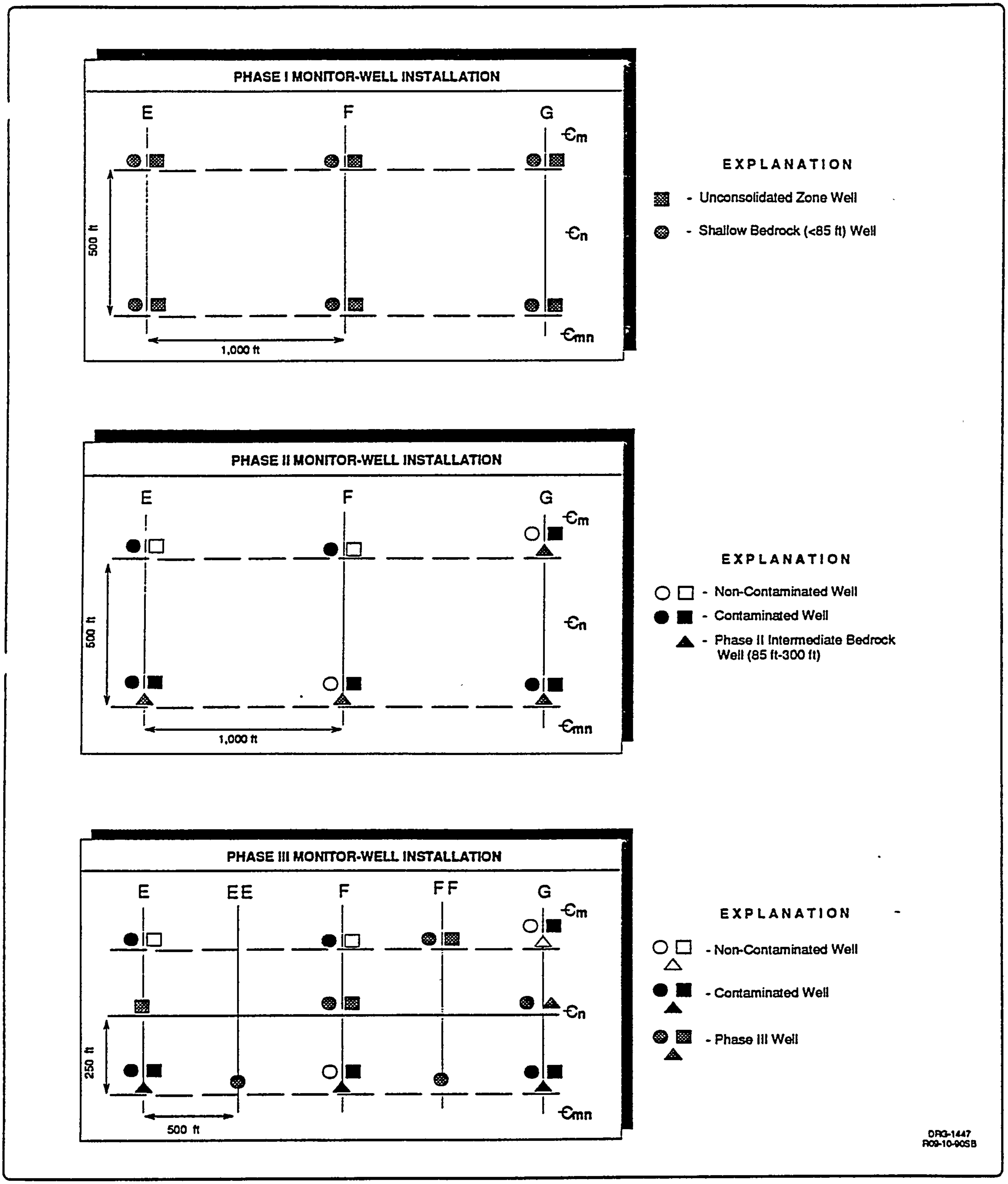


Figure 5-10. Proposed Monitor-Well Installation Sequence for the Upper East Fork Poplar Creek Hydrogeologic Regime

5.2.3.3.4 Implementation Schedule

Implementation of Phase III is completely dependent upon the results obtained during Phases I and II. However, if the number of Phase III monitor wells (as determined from the Phase I and II results) is not excessive (i.e. more than those installed during Phase I) it is anticipated the Phase III program will take about 50 weeks to complete (Figure 5-9).

5.2.4 Recordkeeping and Reporting

Energy Systems currently employs recordkeeping practices that have proven acceptable to the regulatory agencies and no changes to these practices is recommended. Two types of forums will be utilized for the presentation and interpretation of monitoring data collected during investigations in the UEFPC hydrogeologic regime; (1) site-specific reports and (2) reports concerning the entire UEFPC hydrogeologic regime. Soils data collected during contaminant-source identification activities described in Section 5.2.1.1 will be presented and interpreted in site-specific reports (e.g. RFI reports for SWMUs). However, all ground water and surface water data collected during contaminant-plume assessment and exit-pathway monitoring activities will be presented in a single GWQAR for the entire UEFPC hydrogeologic regime. The format for this GWQAR will be similar to that shown on Table 5-6 for the Bear Creek hydrogeologic regime.

5.3 CHESTNUT RIDGE

Of the three hydrogeologic regimes at the Y-12 Plant, Chestnut Ridge contains the least number of potential contaminant source areas; three RCRA interim status TSD units (Table 4-1), six SWMUs (Table 4-2), and one UST (Table 4-4). These sites are generally spaced widely apart and current data indicate that only one site, the Chestnut Ridge Security Pits, has released contaminants to the ground-water system. For these reasons, the current site-specific approach to the identification and assessment of contaminant releases on Chestnut Ridge should be continued.

5.3.1 Contaminant Source Identification

There are ten potential contaminant sources located on Chestnut Ridge; four RCRA TSD units and six SWMUs. Three of the RCRA TSD units, the Chestnut Ridge Sediment Disposal Basin (CRSDB), the East Chestnut Ridge Waste Pile (ECRWP), and Kerr Hollow Quarry have been undergoing detection monitoring and no contaminant releases have been detected at these sites. However, contaminant releases have been confirmed at the fourth RCRA TSD unit, the Chestnut Ridge Security Pits (CRSP) and RCRA ground-water quality assessment monitoring at the site is currently in progress.

At this time, an RFI work plan has been prepared for only one of the six SWMUs located on Chestnut Ridge (the Filled Coal Ash Pond) (Table 4-2). The RFI work plans for the five remaining SWMUs will employ the same technical approach to contaminant source identification as that outlined in Section 5.2.1 for SWMUs in the UEFPC hydrogeologic regime.

5.3.2 Contaminant Plume Assessment

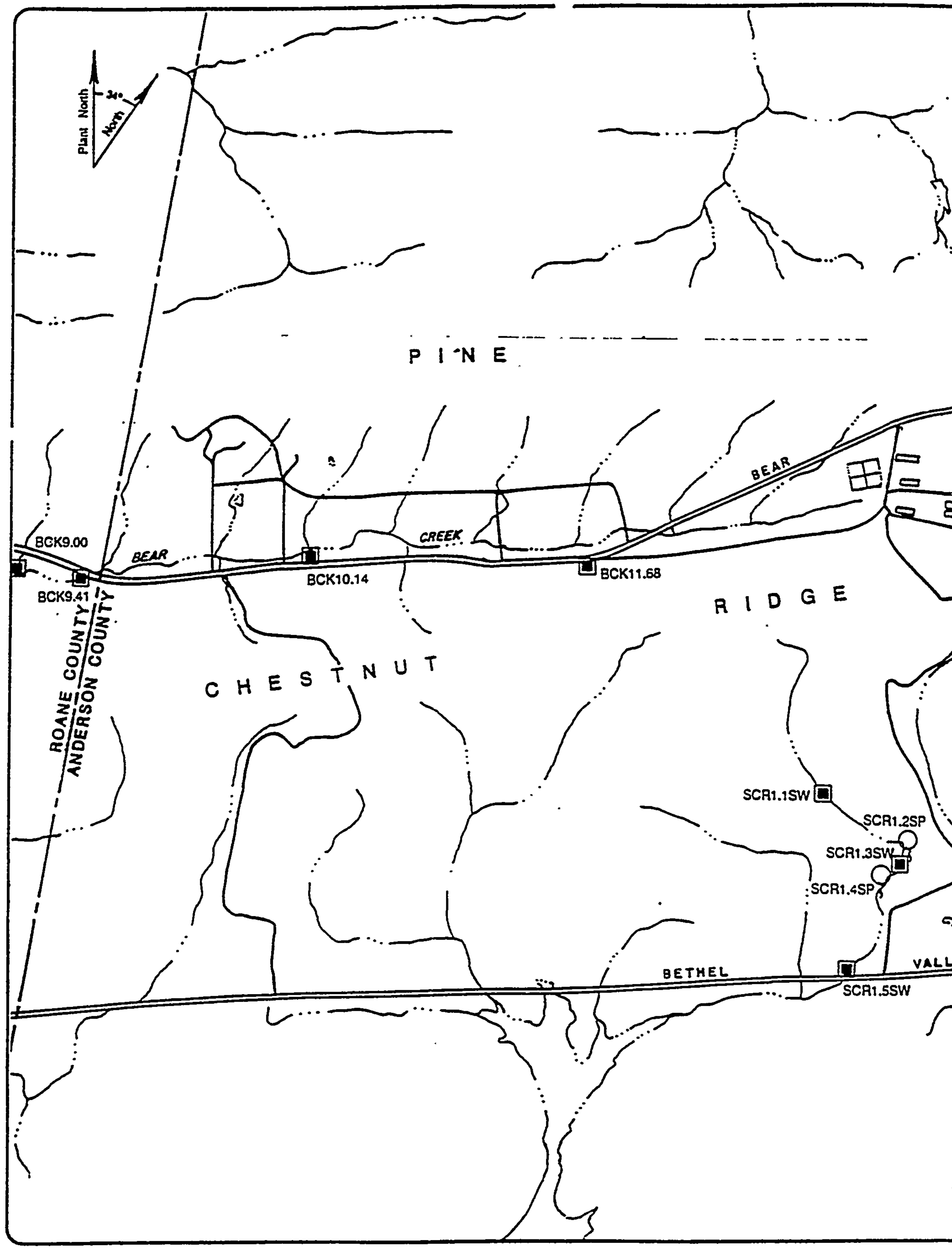
The RCRA assessment monitoring program initiated in January 1988 to determine the rate and extent of contaminant migration from the CRSP will be continued (as per regulatory requirements) until these site-specific objectives are achieved. However, should future monitoring data indicate that contaminants from the CRSP have migrated down the northern ridge flank into the UEFPC hydrogeologic regime, then assessment of the extent of contamination will be incorporated into the overall assessment program outlined for that regime in Section 5.2.2. This same rationale will apply to RFI contamination assessments for the six SWMUs located on Chestnut Ridge.

5.3.3 Exit Pathway Monitoring

Monitoring the quality of ground water and surface water leaving Chestnut Ridge represents the only significant addition to current monitoring efforts. However, the application of the exit pathway monitoring concept to the waste sites located on Chestnut Ridge requires some modification to the approach outlined for the UEFPC and Bear Creek hydrogeologic regimes. The exit pathways for ground-water flow on Chestnut Ridge are not as straightforward as in the UEFPC and Bear Creek hydrogeologic regimes because flow takes place through a labyrinth of interconnected solution cavities and fractures.

As noted in Section 3.2.2.2.2 ground-water flow on Chestnut Ridge is downward and away from the ridge top toward Bear Creek Valley to the north and Bethel Valley to the south. Some ground water discharges through springs and drainage features located on the ridge flanks. These springs represent the natural points of discharge from the cavernous flow system in the Knox Group. In addition, the Maynardville Limestone, which is hydraulically interconnected with the Knox Group, receives ground-water discharge directly from the Knox. Thus, the exit pathways for ground-water discharge from Chestnut Ridge to the north will be monitored as part of the exit pathway and contamination assessment monitoring efforts in the UEFPC and Bear Creek hydrogeologic regimes.

In June 1990, a dye-tracer study was implemented on Chestnut Ridge and in watersheds to the north and south of the CRSP (Geraghty & Miller, Inc. 1990f). The purpose of this study was to determine direction (or directions) of ground-water flow in the karst bedrock zone below the CRSP, and identify points downgradient of the CRSP where ground water discharges to the surface water system. Monitoring locations include wells, springs, and streams within the vicinity of the CRSP (Figure 5-11). The study is to continue for a twelve week period in which passive detectors will be analyzed on a weekly



Plant North
North
34°
PINE
BEAR
BCK9.00
BEAR
CREEK
BCK9.41
BCK10.14
BCK11.68
RIDGE
ROANE COUNTY
ANDERSON COUNTY
CHESTNUT
SCR1.1SW
SCR1.2SP
SCR1.3SW
SCR1.4SP
BETHEL
VALL
SCR1.5SW

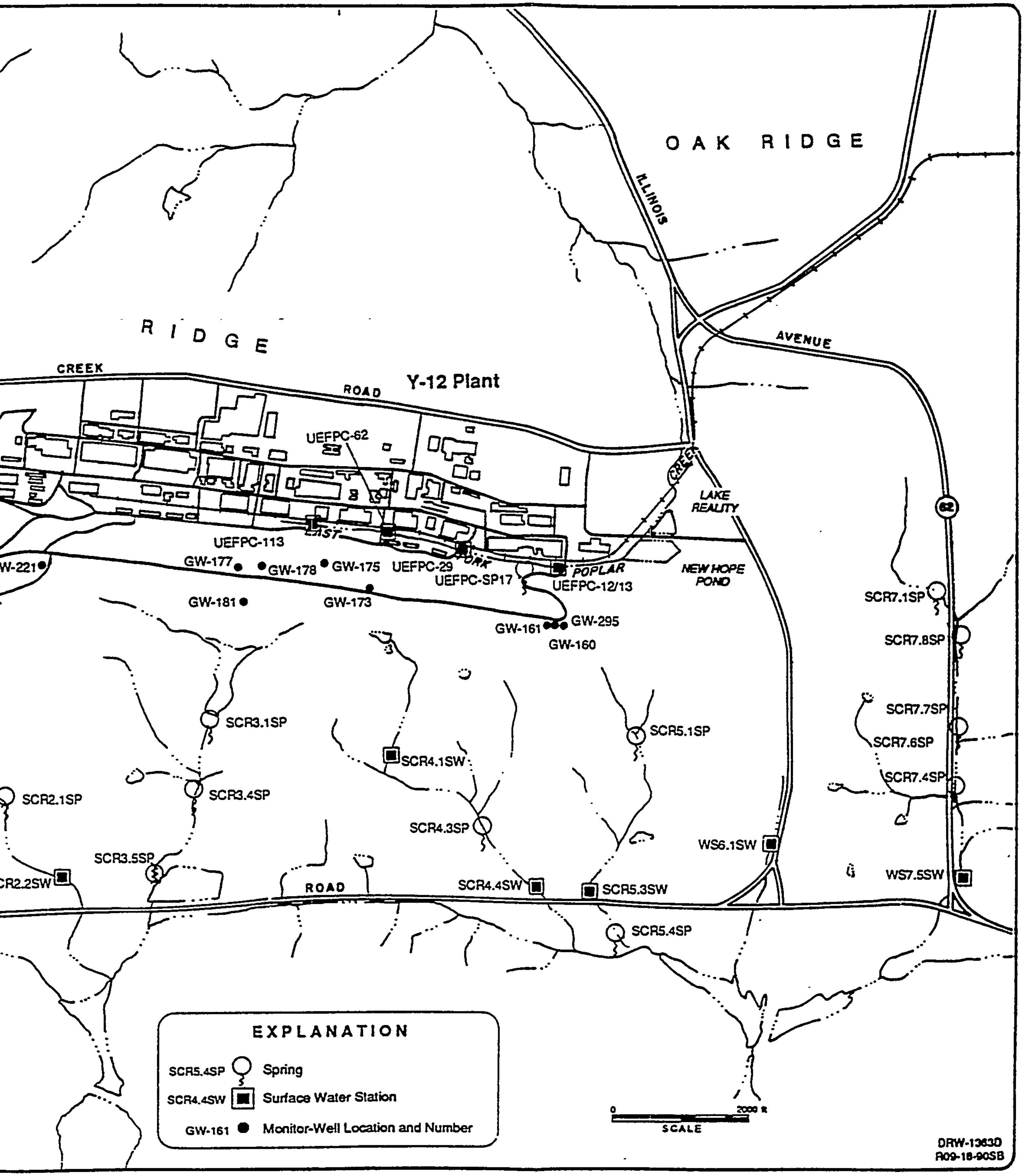


Figure 5-11. Dye Tracer Monitoring Locations

basis for the presence of dye. The exit pathway monitoring program for Chestnut Ridge will then be determined based upon the results of this test and/or subsequent verification studies if deemed appropriate.

An interim exit pathway monitoring program will be implemented until an appropriate program can be determined based on the tracer study. Because ground-water discharge on the southern flank of Chestnut Ridge should be more prevalent in the tributaries that drain the ridge, as evidenced by the number of springs present in these drainage features, the interim monitoring program will focus on surface-water flow leaving the hydrogeologic regime downgradient of the CRSP. Quarterly samples will be collected from the locations indicated on Figure 5-12. Surface-water samples collected from these locations will be analyzed for the standard suite of constituents (Table 5-2) and isotopic uranium. Procedures for sample collection are discussed in Section 6.2.3

5.3.4 Recordkeeping and Reporting

Energy Systems currently employs recordkeeping practices that have proven acceptable to the regulatory agencies and no changes to these practices are recommended. In addition, the current practice of reporting monitoring data and presenting data interpretations in site-specific reports will also be continued. Results of spring and surface water sampling will be presented in the annual GWQAR prepared for the site or sites in RCRA assessment monitoring (i.e. the CRSP).

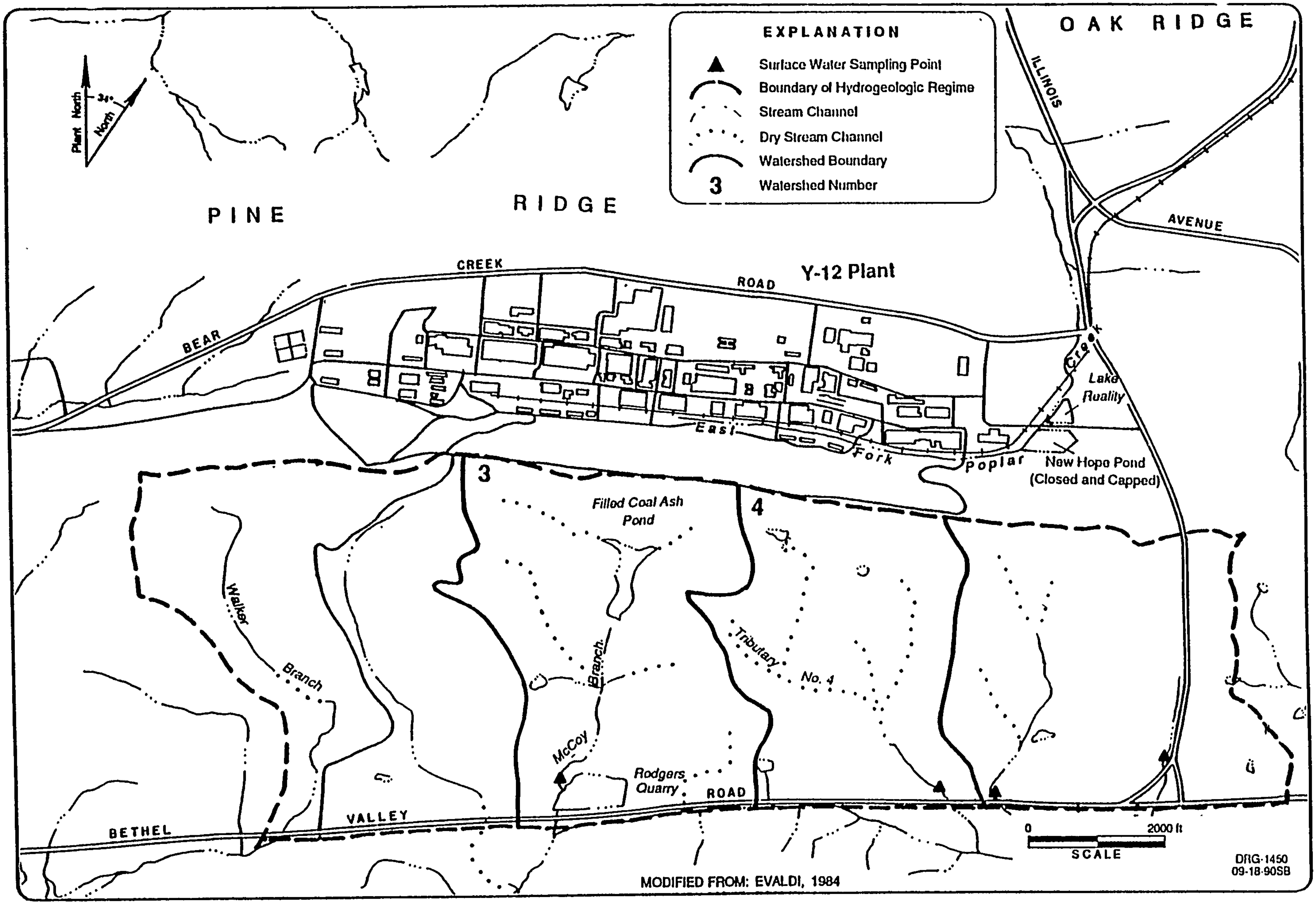


Figure 5-12. Surface Water Sampling Locations Included in the Interim Exit Pathway Monitoring Program for Chestnut Ridge

6.0 QUALITY CONTROL/QUALITY ASSURANCE

Standardized protocols and procedures have been established to maintain quality assurance/quality control (QA/QC) of environmental monitoring activities at all waste sites associated with the Y-12 Plant, regardless of the regulatory program (e.g RCRA) under which each site is managed. These protocols and procedures are described in detail in "Environmental Surveillance Procedures Quality Control Program, Martin Marietta Energy Systems, Inc." prepared in September 1988 (Martin Marietta Energy Systems, Inc. 1988) and approved by the EPA and TDHE in November 1988. Standardization of the Environmental Surveillance Procedures (ESP) has successfully worked to simplify the organization, management, and implementation of monitoring activities at the Y-12 Plant.

The following sections discuss applicable ESP to be employed in the monitoring activities described in this report. However, only a general description of these procedures is provided; specific procedure identification numbers (e.g. ESP-600) are cited to aid readers seeking more detailed descriptions of methods and procedures.

6.1 SUBSURFACE INVESTIGATIONS

Prior to initiating site-specific subsurface investigations at the Y-12 Plant, such as those performed under RFIs, an initial survey of the site is conducted in accordance with ESP-200. Included in the site survey are a review of site records, the acquisition of required excavation permits, an evaluation of site access, health and safety considerations, and the selection of the appropriate technical approach to meet the objectives of the investigation.

6.1.1 Soil Borings

Soil borings are accomplished in accordance with the standards presented in ESP-303 and are usually performed with a truck-mounted auger drill rig. Throughout all drilling activities, decontamination protocols and health/safety protocols are maintained. All subsurface materials are screened for contamination as part of the health/safety monitoring requirements, and to determine appropriate disposal procedures. All soil drilling activities are supervised and documented by a professional geologist or engineer.

6.1.2 Monitor-Well Installation and Construction

Ground-water monitoring wells at the the Y-12 Plant are designed, constructed, and installed in accordance with the procedures described in ESP-600. These procedures incorporate state-of-the-art design and construction techniques available from both government and industry documents. Use of these protocols and procedures help ensure that monitor well installation and construction practices at the Y-12 Plant comply with all applicable State and Federal regulations.

Monitor-well installation and construction techniques are directed towards ensuring well integrity and include the following quality-control practices:

(1) All drilling operations are supervised by a qualified hydrogeologist to ensure and document proper well construction.

(2) All monitor wells are drilled using methods which minimize disturbance to in situ materials and prevent the introduction of potential contaminants during drilling. This includes utilization of multiple, telescoped surface-casing in selected situations to seal off shallow contaminated zones.

(3) Drill rigs and support equipment are steam cleaned prior to mobilization on each well site and as needed during drilling. Water used for steam cleaning is from an approved source.

(4) All monitor wells are constructed of inert materials which, to the extent possible, do not impact ambient ground-water chemistry in the well.

(5) The relationship between the diameter of the borehole and the diameter of the well casing is such that a sufficient annulus is present to facilitate adequate placement of the monitor well components, i.e., filter pack, bentonite seal, and annular grout.

(6) All monitor wells are completed with either protective surface casings with locking caps, or vented and padlocked well caps. A concrete pad is installed at each well with protective posts at each corner.

(7) All monitor wells are developed using appropriate techniques that involve the withdrawal of at least three well volumes of water, or continued withdrawal until the water is sediment free or the temperature, pH and conductivity have stabilized.

Three basic types of monitor well designs are used at the Y-12 Plant: (1) wells with no surface casing and screened in unconsolidated material or weathered bedrock, (2) wells with surface casing and screened in competent bedrock, and (3) wells with surface casing and completed in competent bedrock with an open interval. Schematic diagrams illustrating these well designs are presented on Figures 6-1, 6-2, and 6-3, respectively.

Routine preventive maintenance of all monitor wells at the Y-12 Plant is performed as needed. In general, all monitor wells are inspected quarterly for damage and security (i.e., locked protective caps). Damage resulting in a compromise of well integrity (e.g. the annular seal between the well casing and the borehole has been breached) requires the abandonment and plugging of the well.

6.1.3 Piezometer Installation and Construction

Piezometers are installed in accordance with the same procedures employed during monitor well installation and construction (ESP-600). However, because piezometers are generally utilized for hydrologic monitoring purposes only (i.e. water levels) and are not intended for long-term ground-water quality monitoring, their construction standards differ from those specified for monitor wells. These differences include the use of polyvinyl chloride (PVC) well casing (monitor wells are constructed of stainless steel casing and screens), and the absence of surface casings, protective casings, and concrete pads. A schematic diagram illustrating typical piezometer construction is provided on Figure 6-4.

6.1.4 Plugging and Abandonment Procedures

Throughout the course of monitoring activities at the Y-12 Plant, damaged, un-used, and obsolete monitor wells and piezometers have been and will be plugged and

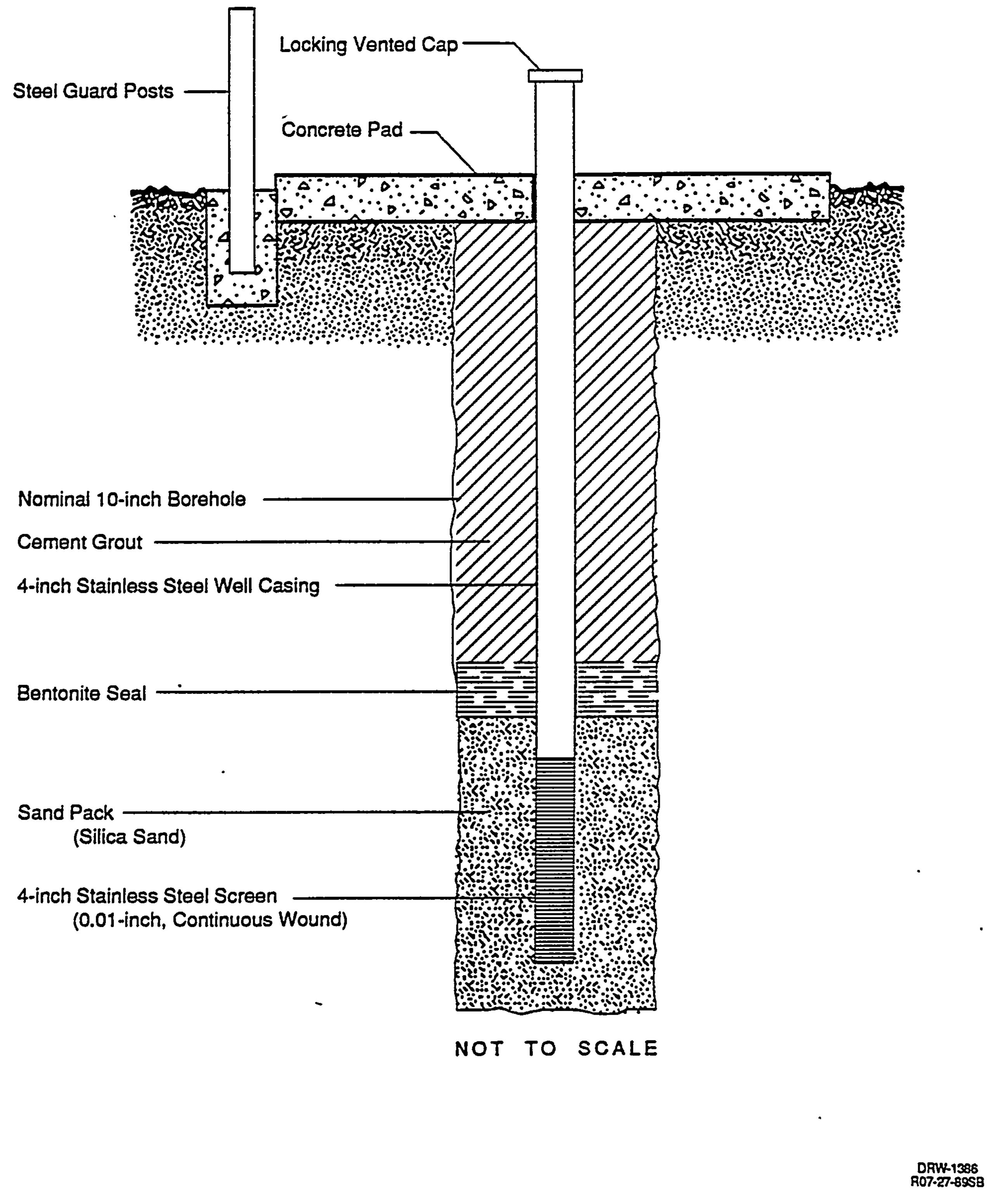


Figure 6-1. Generalized Construction Diagram of Monitor Well with Screened Interval in Unconsolidated Material

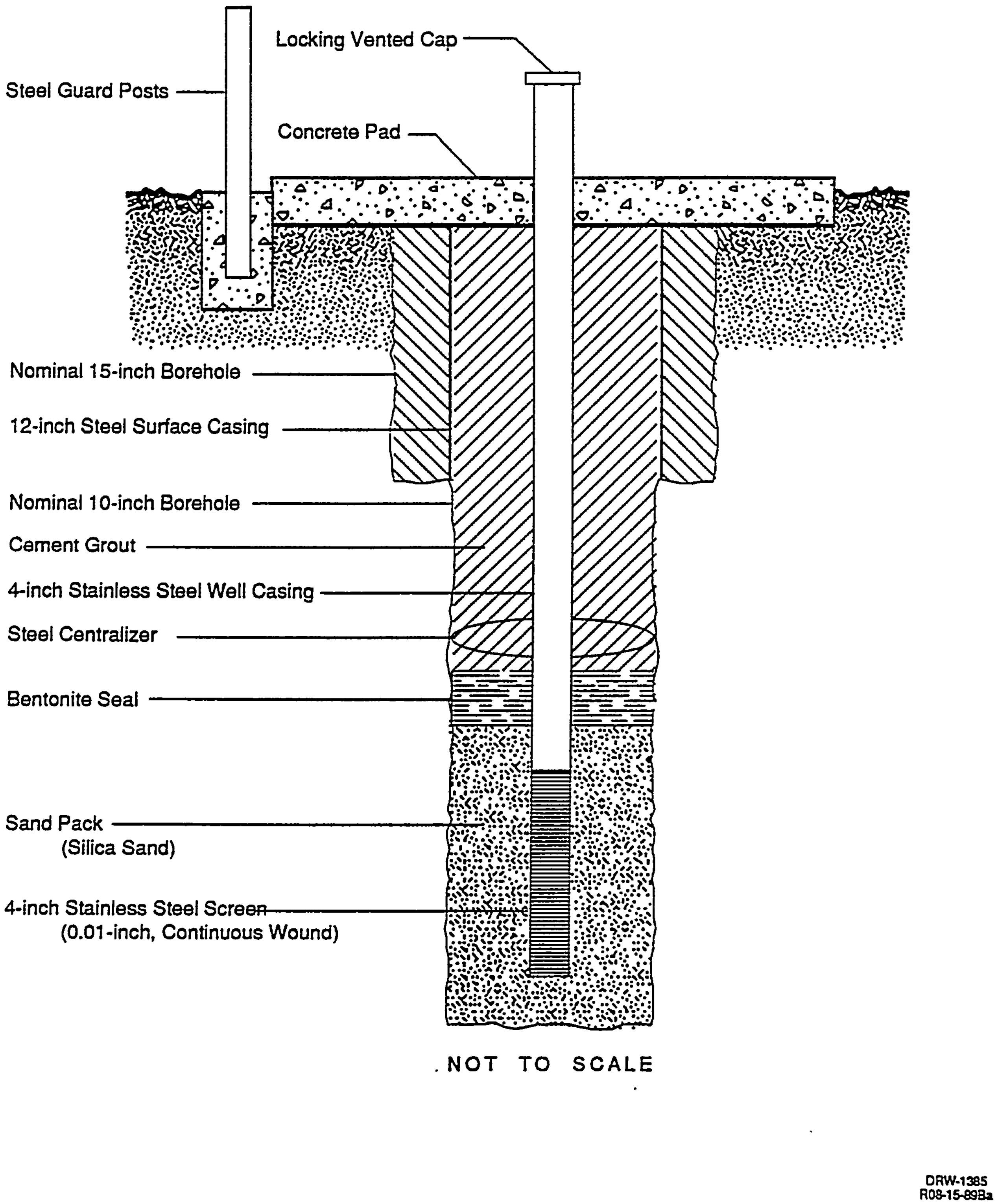


Figure 6-2. Generalized Construction Diagram of Monitor Well with Screened Interval in Bedrock

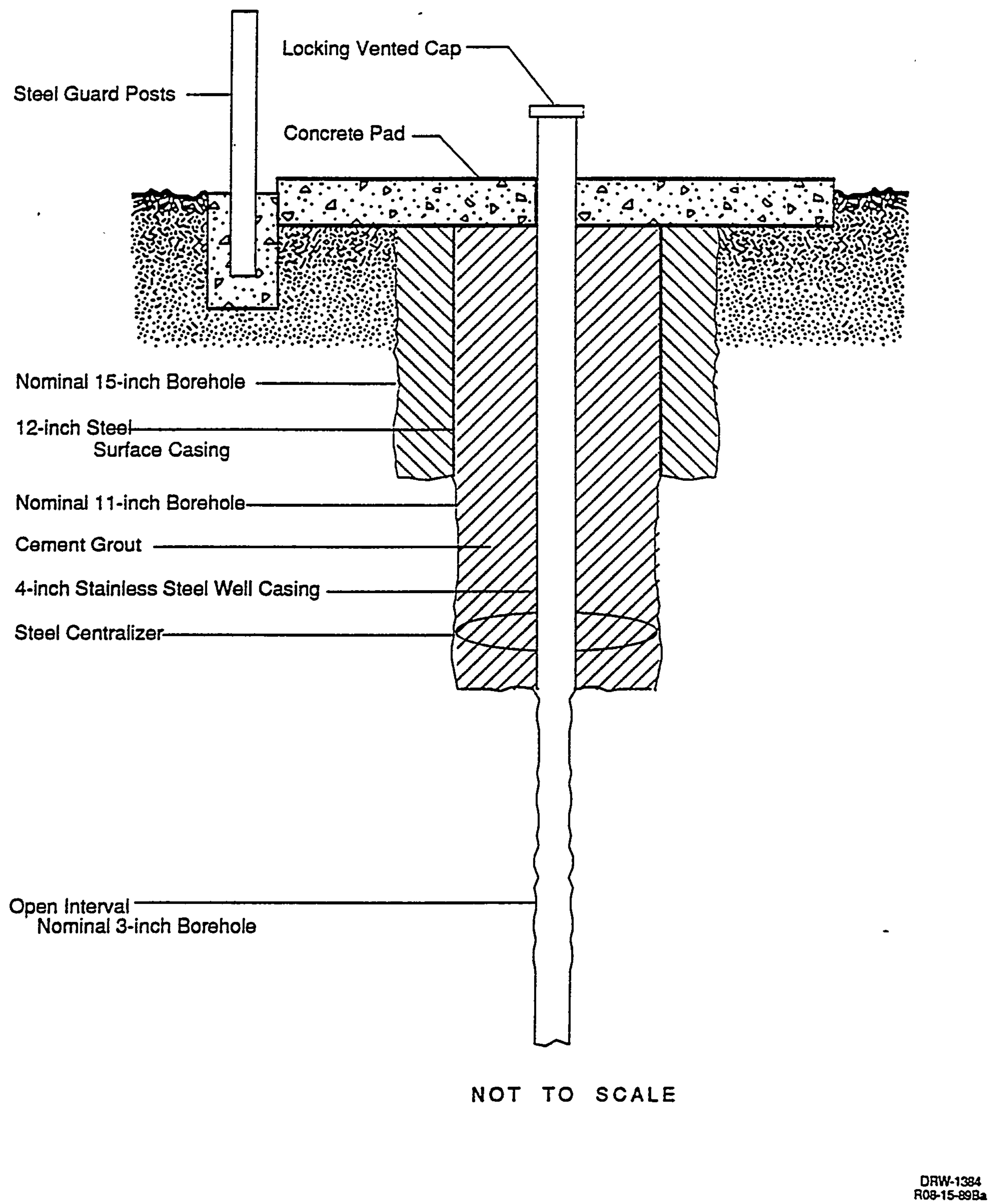


Figure 6-3. Generalized Construction Diagram of Monitor Well with Open Interval in Bedrock

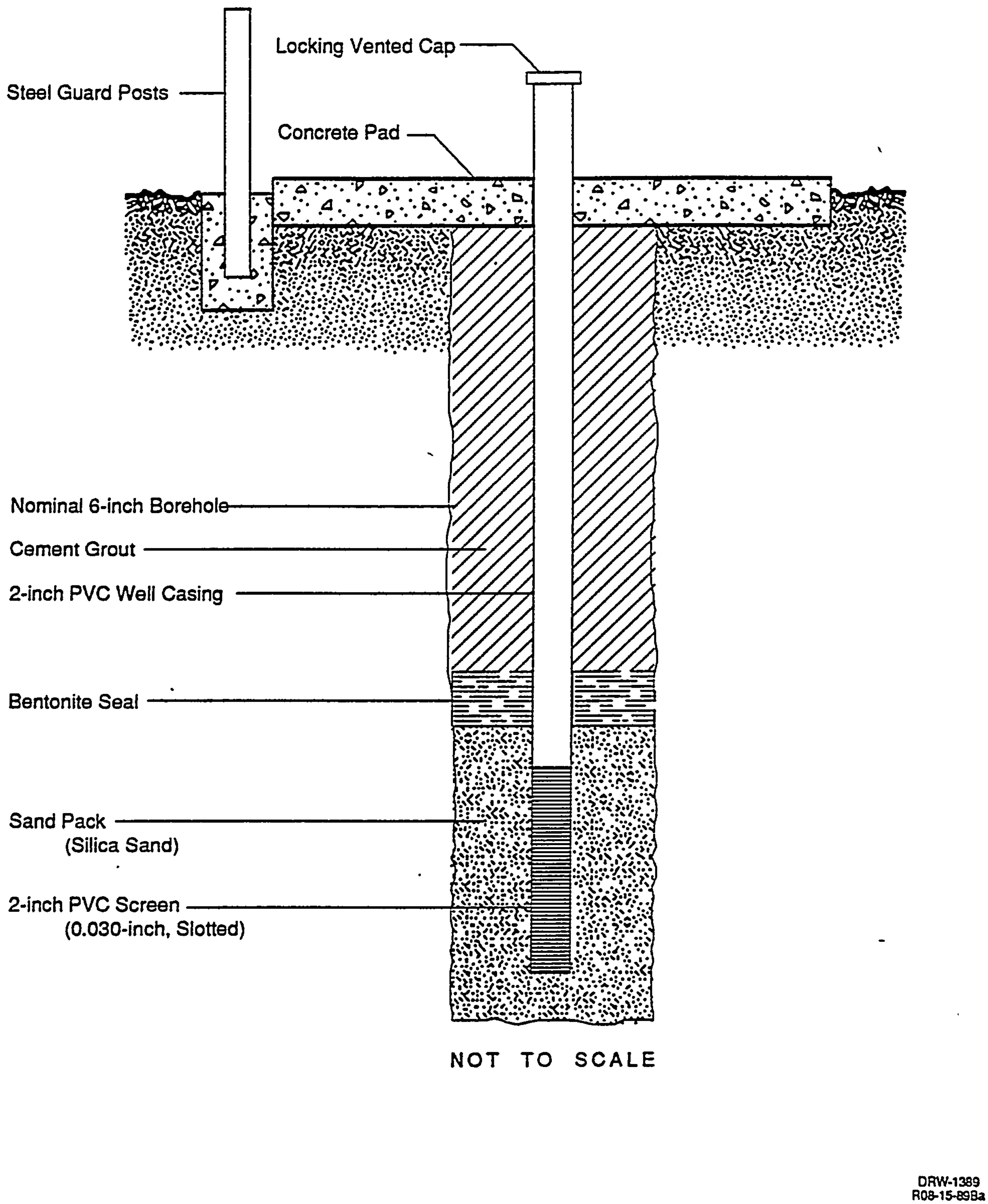


Figure 6-4. Generalized Construction Diagram of Piezometer with Screened Interval in Unconsolidated Material or Bedrock

abandoned in accordance with the procedures outlined in ESP-600 Section VII(E). In general, the plugging of wells and piezometers involves removal of casings and screens, and grouting the borehole from the bottom up by the tremie method until grout is circulated to the surface. The well site is then checked for grout settlement after 24 hours and any depressions are re-filled with grout and re-checked until hardened grout is flush with the ground surface. All casings, screen or other material removed during plugging are evaluated for contamination and disposed of or decontaminated accordingly.

6.2 SAMPLE COLLECTION PROCEDURES

The sample collection procedures described in Energy Systems ESP document follow a standard format. A detailed narrative of the sampling procedure is provided, along with descriptions of the required equipment and apparatus, health and safety considerations, contamination control, quality-control sampling (i.e. collection of blank samples), and a quality control field checklist. In addition, separate sections describing certain aspects common to all sampling activities are also provided. These include procedures for field quality control (ESP-400), chain-of-custody procedures (ESP-500), sample preservation and container materials (ESP-701), packaging of samples for transportation (ESP-800), and cleaning and decontaminating sample containers and sampling devices (ESP-900).

6.2.1 Soil Sampling

Soil samples will be collected in accordance with the procedures outlined in ESP-303. Several sampling methods are described, including sampling with a spade and scoop (ESP-303-1), sampling with an auger (ESP-303-2), sampling with a trier (ESP-303-3), penetrations test and split-barrel sampling (ESP-303-4), sampling with Shelby tubes (ESP-303-5), and rock coring (ESP-303-6). Procedures for collection of composite soil samples are described in ESP-308.

6.2.2 Ground-Water Sampling

Ground-water samples from wells included in the monitoring program for each hydrogeologic regime will be collected in accordance with the procedures outlined in ESP-302. Described are procedures for water-level measurements (ESP-302-1), well purging prior to sample collection (ESP-302-2), and sample collection methods using a bailer (ESP-302-3), a gas driven piston pump (ESP-302-4), and a bladder pump (ESP302-5). To avoid or reduce the potential for cross-contamination, monitor wells in each hydrologic regime or at individual waste sites will be monitored (water-level measurements and water-quality sampling) in a predetermined sequence. Wells or piezometers located upgradient of contaminant sources (background wells) will be monitored first. For wells located downgradient of contaminant source areas, the least contaminated wells will be sampled first and the most contaminated wells will be sampled last. If there is no data regarding the degree of contamination in the monitor wells, then the furthest downgradient wells will be sampled first and the wells closest to contaminant source areas will be sampled last.

6.2.3 Surface-Water Sampling

Surface-water samples associated with the migration pathway monitoring program in each respective Bear Creek hydrogeologic regime will be collected in accordance with the procedures outlined in ESP-301. Described are procedures for stream-flow measurements (ESP-301-5) and sample collection using a dipper (ESP-301-1), a peristaltic pump (ESP-301-2), an automatic sampler (ESP-301-3), and grab sampling with Kemmerer bottles (ESP-301-4). Selection of the appropriate sampling method is based upon program objectives and the initial site survey.

6.3 ANALYTICAL PROCEDURES

Specific methods for the chemical analysis of soil, surface water, and ground-water samples are referenced in ESP-700. The procedures include those that meet the requirements of the RCRA and CERCLA regulations, the Clean Water Act, and the National Primary Drinking Water regulations. Because there is usually more than one analytical method for most of the analytical parameters to be measured, guidance for the selection of the appropriate analytical methodology is provided. Factors to be evaluated in the selection of the appropriate method include the physical state of the sample, the anticipated concentrations of analytes, the required detection limit, data-quality objectives, regulatory requirements, laboratory capabilities, and cost of the analysis.

In addition to providing guidance for the selection of appropriate analytical methods, ESP-700 also defines five levels of analytical quality control. Level I is defined as field screening using portable instruments. Results obtained at Level I are considered qualitative. Level II is also a field procedure, but more sophisticated portable instruments are utilized. Data obtained at Level II may be qualitative or quantitative depending upon a number of factors (e.g. operator training and skill). Levels III and IV require laboratory analyses in accordance with EPA approved procedures. Quantitative and qualitative data are generated at each level, but the degree of data-validation and documentation at Level III is less than at Level IV, which is equivalent to the EPA Contract Laboratory Program (CLP) and requires rigorous data validation protocols and documentation. Level V also requires laboratory analyses, but by non-standard methods, and would generally be used in analyses for "exotic" analytes, such as radionuclides, for which no standardized analytical methods have been developed.

6.4 DATA MANAGEMENT

A vast amount of data is generated by the various surface water and ground-water monitoring programs at the Y-12 Plant. To manage the data effectively, it has been summarized in two preliminary computerized databases: subsurface data and water-quality data. The following sections outline the general aspects of each database.

6.4.1 Hydrogeologic Database

Subsurface geologic and hydrogeologic data obtained from coreholes, boreholes, borings, piezometers, and monitor wells in BCV, on Chestnut Ridge, and in parts of Bethel Valley have been summarized in a database (Haase, Gillis, and King, 1988). The database contains well installation and construction data regarding survey coordinates, elevation, total depth, completion method, borehole diameter, casing and screen materials, filter pack depths, screened intervals, open-hole intervals, and open-hole diameters. Hydrogeologic data obtained from various subsurface investigations and summarized in the database include depth to weathered and fresh bedrock, geologic formations penetrated, and whether rock core and geophysical logs were obtained (Haase, Gillis, and King, 1988).

The database is updated periodically as new coreholes, boreholes, and monitor wells are drilled. Applications of the database include evaluation of the suitability of wells for continued use in ground-water investigations and monitoring studies, site hydrogeological characterizations, background evaluations of sites prior to initiation of new drilling activities, and geophysical review of selected sites prior to the initiation of remedial actions (Haase, Gillis, and King, 1987).

6.4.2 Environmental Monitoring Database

H&R Technical Associates, Inc. (H&R), under contract to Energy Systems, manages the soil, surface-water and ground-water quality data for the Y-12 Plant. H&R's data management duties include quality assurance and quality control (QA/QC), storage and distribution, and statistical data manipulations.

A majority of the analytical data is supplied by the Oak Ridge Gaseous Diffusion Plant laboratory (K-25). In addition, H&R also receives data from other laboratories contracted by Energy Systems. Environmental monitoring data from K-25 is transferred to H&R in electronic and hard-copy form. Until recently, other laboratories generally transmitted only hard copies of their data. However, some of the laboratories have begun using personal computers to record the data which is then transmitted to H&R on diskettes.

An IBM mainframe computer at the Oak Ridge National Laboratory, which H&R is authorized to access, is used to store environmental monitoring data collected at the Y-12 Plant. Data from K-25 is entered by laboratory personnel into an Analis data-base software system and transferred to the IBM mainframe. If only hard copies of laboratory results are available, H&R hand-enters the data from the hard copy. To maintain QA/QC, H&R enters this data two separate times and compares the output for discrepancies. Any disagreement of data is checked against the hard copy, and corrected.

Once the data have been entered onto the IBM main-frame, H&R employs QA/QC software that prepares the data for entry into a Statistical Analysis System (SAS) software program. The QA/QC software proofs for correct spelling of chemical names and checks consistency in chemical units. In addition, H&R has begun implementing an additional QA/QC check of Chemical Abstract Series (CAS) numbers assigned to each constituent to avoid duplication of entries for chemicals with pseudonyms. If data have been transferred to H&R in both electronic and hard copy form, a final QA/QC check of the data is performed by comparing the SAS data output against results reported in hard copy. If discrepancies are noted between the SAS download and the hard copy, the appropriate laboratory is contacted. Discrepancies confirmed by the laboratory are corrected in the SAS database, if necessary.

H&R distributes either electronic or hard copy print-outs of the water-quality data only to users authorized access by Energy Systems. The authorized user must first formally request the data in writing. The data are then transferred by H&R to the user with an accompanying cover letter documenting the data transmittal.

6.5 DATA EVALUATION AND ANALYSIS

As discussed in the preceding sections, standardized methods for the collection and analysis of soil, surface water, and ground-water samples have been developed. In addition to these procedures, a standardized procedure for the analysis of ground-water monitoring data has also been developed and is contained in a draft report entitled "Data-Evaluation Procedures for Ground-Water Contamination Assessment Programs at the Y-12 Plant, Oak Ridge, Tennessee" (Geraghty & Miller, Inc. 1990g). This procedure was specifically developed to provide guidance in the evaluation of ground-water contamination assessment data and therefore may or may not apply in the evaluation of chemical data for soils and surface water.

The objective of the data-evaluation procedure is to provide a standardized method that is less prone to overly subjective and qualitative interpretations which may result in divergent or inconsistent assessments of the extent and severity of ground-water contamination at the Y-12 Plant. As illustrated on Figure 6-5, the data-evaluation process involves two basic steps; (1) the identification of constituents present in ground water at a site, and (2) the identification of contaminants present in ground water at concentrations that may pose a threat to human health and the environment. Although the procedures

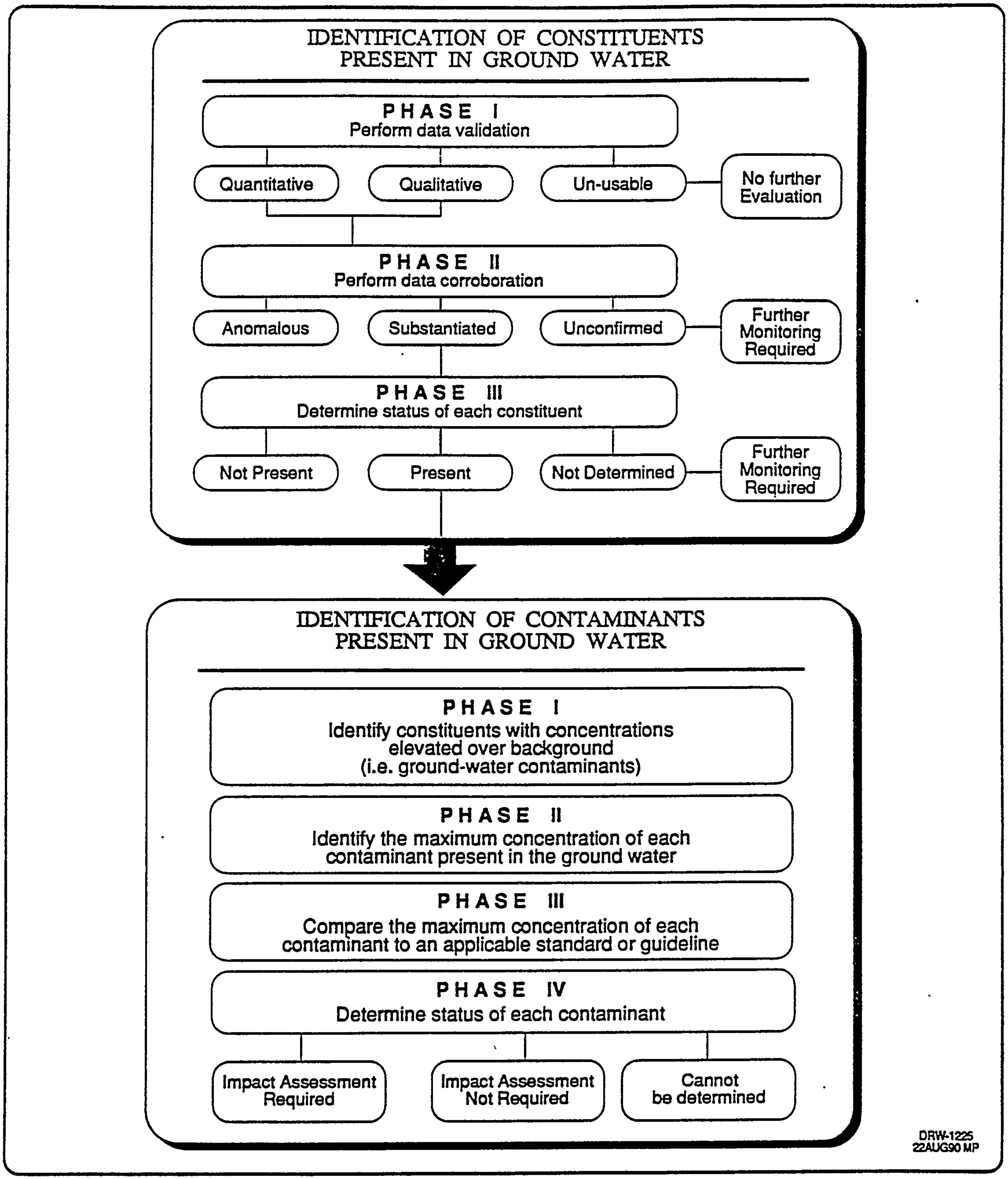


Figure 6-5. Overview of the Data Evaluation Process

involved are quantitative and a conservative approach is taken at each decision making step, the final evaluation of which contaminants may pose a threat to human health and the environment must incorporate professional judgement.

The identification of the constituents present in ground water is accomplished in three phases: (1) the validation of the analytical results to identify invalid or suspect data; (2) the corroboration of the validated results with historical data; and (3) the determination of the status of each constituent (i.e. present, not present, not determined) based upon the validated and corroborated data.

Four phases are employed to identify ground-water contaminants present at concentrations that may pose a threat to human health and the environment; (1) the identification of constituents with concentrations elevated over background levels (i.e. ground-water contaminants), (2) the identification of the maximum concentration of each contaminant, (3) a comparison of the maximum concentrations to applicable water-quality standards and health based guidelines, and based upon this comparison (4) the identification of "contaminants of concern" for which studies to determine their potential for adverse impacts on human health and the environment will be required.

Use of the data-evaluation procedures outlined above yield a more precise picture of the extent and severity of ground-water contamination. In addition, experience has shown that this picture to be more consistent over time than that described by data not processed through the procedure. Furthermore, standardization of these procedures provides a solid foundation for accurate identification of ground-water contaminants from which decisions regarding risk assessment and corrective actions can be based.

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- Y-12 PLANT GEOLOGY
  - General
  - Bear Creek Valley
  - Chestnut Ridge
- GEOPHYSICAL INVESTIGATIONS
- Y-12 PLANT HYDROGEOLOGY
  - General
  - Bear Creek Valley
  - Chestnut Ridge
  - Aquifer Properties
  - Monitor-Well Installation Documentation
  - Water-Quality Monitoring Data
  - Computer Modeling
- SURFACE-WATER HYDROLOGY
  - General
  - Bear Creek Valley
  - Chestnut Ridge
  - Water-Quality Monitoring Data
- SOILS AND SEDIMENTS
  - General
  - Bear Creek Valley
  - Chestnut Ridge
  - Geotechnical Data
  - Geochemical Data
- WASTE CHARACTERIZATION AND INVENTORIES
  - General
  - Bear Creek Valley
  - Chestnut Ridge
- CONTAMINATION ASSESSMENTS
  - General
  - Bear Creek Valley
  - Chestnut Ridge
- REGULATORY DOCUMENTS
  - RCRA Closure/Post-Closure Plans
  - RCRA Post-Closure Permit Applications (PCPAs)
  - RCRA Ground-Water Quality Assessment Plans (GWQAPs)
  - RCRA Ground-Water Quality Assessment Reports (GWQARs)
  - RCRA Alternate Concentration Limit (ACL) Demonstrations
  - RCRA Facility Assessments (RFAs)

REGULATORY DOCUMENTS (cont.)

- RCRA Facility Investigations (RFIs)
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